بِسۡمِ اللّٰہِ الرَّحۡمٰنِ الرَّحِیۡمِ

(In the Name of Allah, the Most Compassionate, the Most Merciful.)

GENERAL SCIENCE

7

Web Version of PCTB

Based on Single National Curriculum 2022

ONE NATION, ONE CURRICULUM

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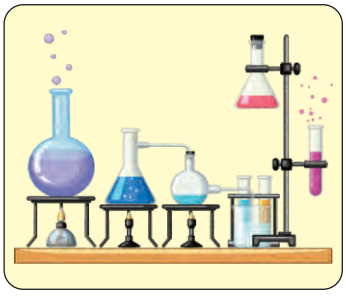
A WINDOW INTO LEARNING SCIENCE AND TECHNOLOGY



Science is research-based knowledge, practice-based skill and inquiry-based approach to investigate and learn further through scientific method. The key activities involved in scientific method are observation, experimentation and deduction. Technology is application of scientific knowledge for solving daily life problems, making arduous works easy and improving quality of life. In order to meet the globally recognized standards, we need to broaden our educating horizons and adopt scientific method to learn science.

The inquiries and activities of scientific method involve observations, experimentations and conclusions. Hypothesis, theory and principle, etc., are the developmental stages in scientific research.

General Science for Grade 7 is the second annual course of studies designed in Single National Curricula for Elementary Level Students. This manuscript is an attempt to be proved as the best Textbook for the said course of studies. Use of scientific method in the teaching-learning approach equipped therein the textbook makes it entirely different from the textbooks in the subjects of humanities group.

It has been developed as a source of information and tools for applying scientific method in research based studies.

Students' interest has been engaged in process based learning, in-depth studies and inquiries for making observations and conclusions through experiments, child-centered and teacher-guided activities and in doing science and technology.

Acknowledgment

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Appeal

Valuable suggestions for the improvement of this book are cordially invited.

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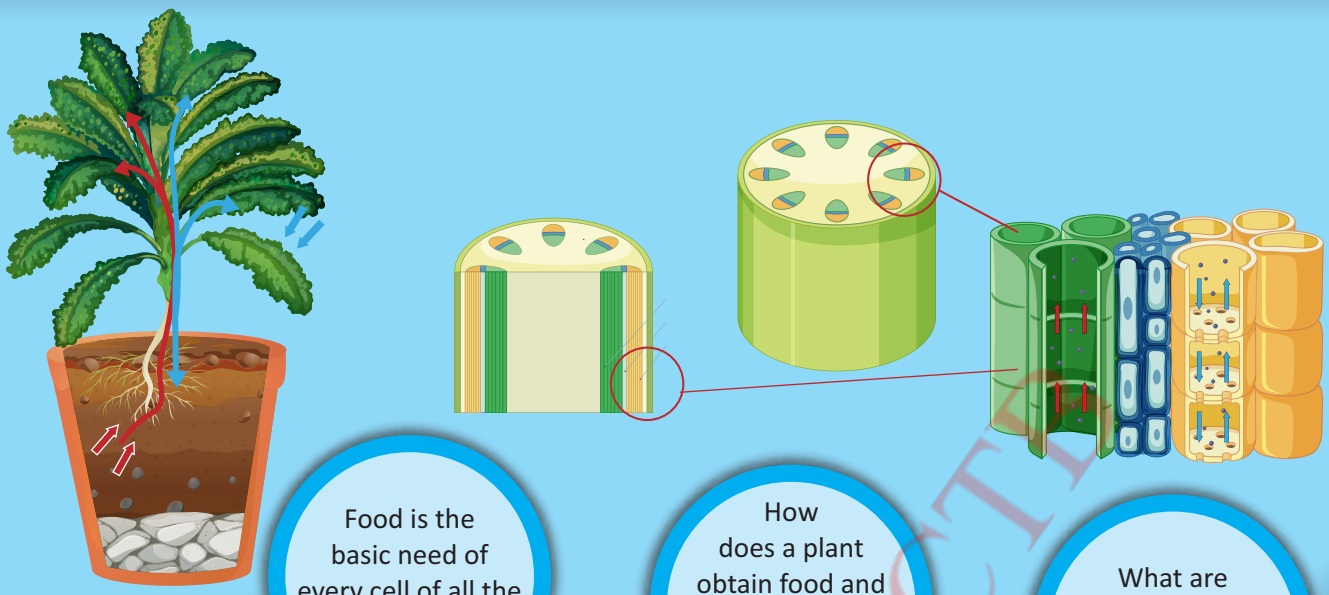

Food is the basic need of every cell of all the organisms

How does a plant obtain food and transport it to every cell of its body?

What are vascular bundles and their function in plants?

01 Plant Systems

Students' Learning Outcomes

After studying this chapter, students will be able to:

- Explain the root and shoot system in plants. Label different parts of leaf, stem and root (external and internal structure).
- Predict the role of xylem and phloem in transport of water and food in plants by observing the cross section of the stem.
- Define the process of photosynthesis and derive word equations for it.
- Know that plants require minerals to maintain healthy growth and life processes (limited to magnesium to make chlorophyll and nitrates to make proteins).
- Explain that the structure of leaves is adapted to the process of photosynthesis.
- Describe the process of respiration and write word equations for it. Compare and contrast the processes of photosynthesis and respiration.
- Investigate the phenomena of transpiration and its importance in a plant (wind, temperature, light, humidity affecting rate of transpiration in plants).
- Explore and apply natural raise of water based on the principle of transpiration.

VOCABULARY

Root hairs	Vascular bundles	Mesophyll cells	Chlorophyll	Stomata	Transpiration
Outgrowths of epidermal cells in plant roots which absorb water and nutrients from the soil	A system consisting of xylem and phloem for conduction of water and transport of food in plants	Cells which are rich in chloroplast and specialized for preparation of food during photosynthesis	Green coloured pigment in chloroplast which absorbs light photosynthesis	Tiny openings in plant leaves for gaseous exchange and removal of extra water	Loss or removal of extra water from aerial parts of plants

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Recall what you have learnt

We have learnt about:

- Organs and organ systems in plants **(Figure 1.1)**
- Root and shoot system in plants
- Xylem and phloem
- Chloroplasts

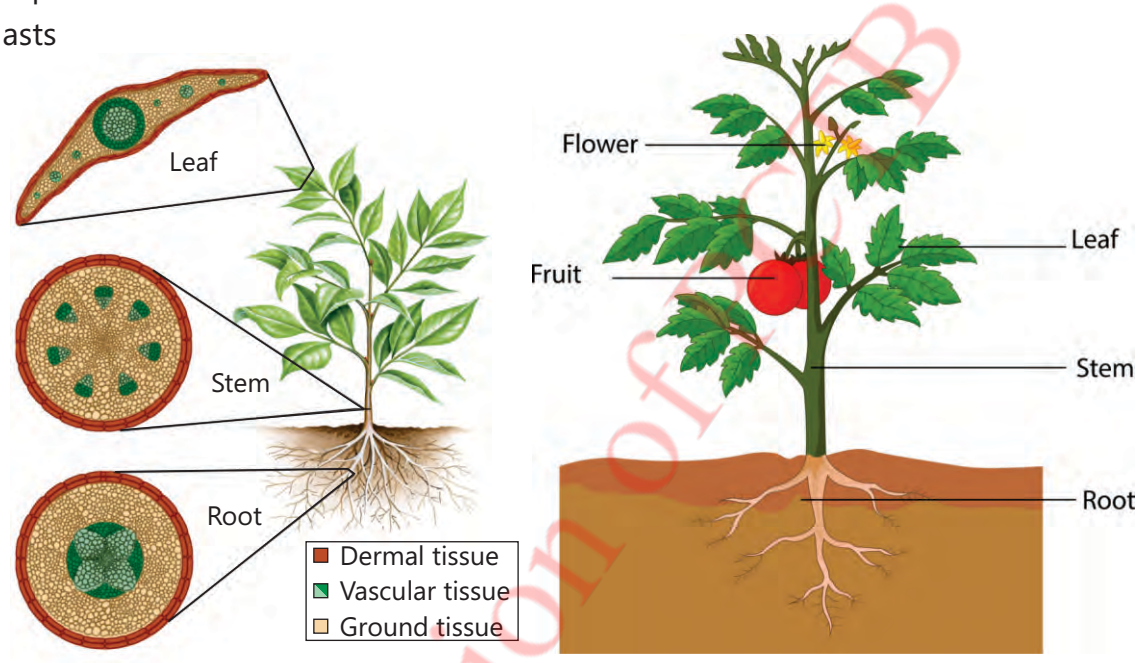

Figure 1.1 Organs and organ systems in plants

Activity 1.1 Assessment

Write **'C'** against the correct and **'I'** against the incorrect statement in the middle column. Also correct the incorrect statement and write it in the next column.

Correct/Incorrect	C/I	Correct statement
Leaves in plants absorb water and nutrients from soil.		
Photosynthesis takes place in the underground parts of the plants.		
Xylem tissue conducts water from roots to leaves.		
Phloem transports food from leaves to other parts of the plant.		

In this chapter we will learn the following systems in plants:

- Root and shoot system
- Respiration
- Photosynthesis
- Transpiration

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1.1 ROOT AND SHOOT SYSTEM IN PLANTS

1.1.1 Root System

Roots are the underground parts of the plants forming a system specialized for absorption of water and minerals from the soil **(Figure 1.2)**.

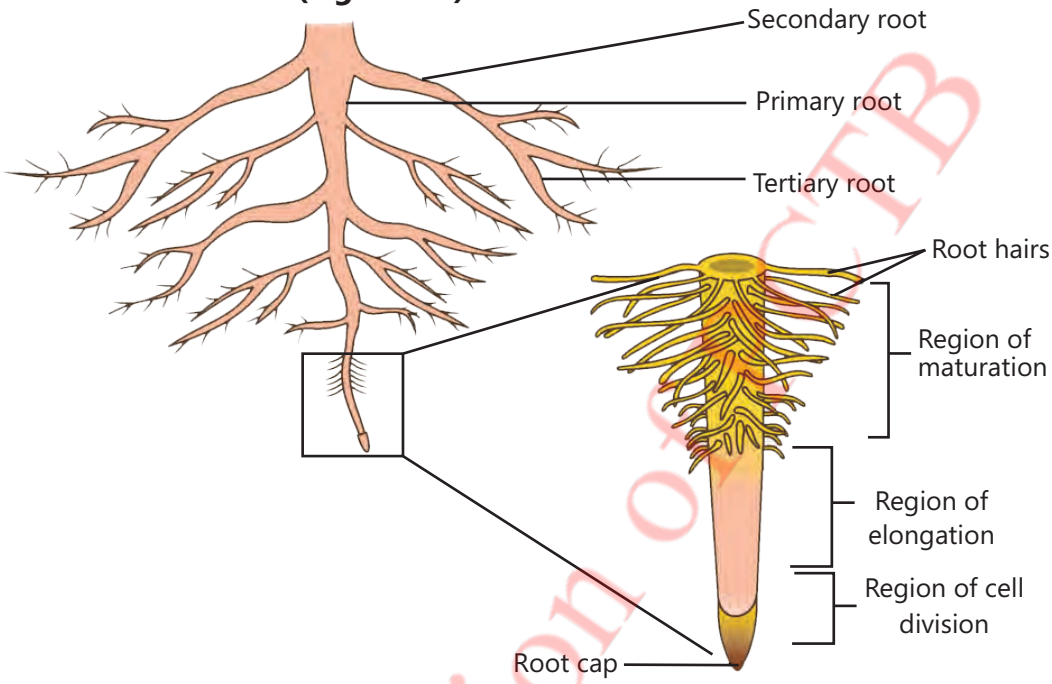

Figure 1.2 Parts of root

Recall

- Zygote is the first cell formed by the fusion of reproductive cells (male and female gametes) during sexual reproduction of plants and animals.
- The initial stage of development of multicellular organisms formed by the cell divisions and growth of zygote is called embryo.

The initial root which grows from radicle of the embryo is the **primary root or tap root**. Its further branches form **secondary** and **tertiary** root system. The tips of roots and shoots in plants consist of tissues formed by the cells called meristematic tissues. These cells are specialized for growth. These cells increase in number by rapid cell division.

Root tip is covered by hard and protective structure called **root cap**. It protects the newly born soft cells from being damaged and environmental stresses. It enables root tip to grow through soil. More and more cells are formed by rapid cell divisions in this region causing the root to grow deep into the soil and elongate the root behind. The **region of maturation** has root hairs. **Root hairs** are thread like outgrowths of epidermal cells which increase the surface area for absorption of water. Plants, like grasses and strawberry have thread like roots spread in soil but not growing deep. Such roots are called **fibrous roots (Figure 1.3)**.

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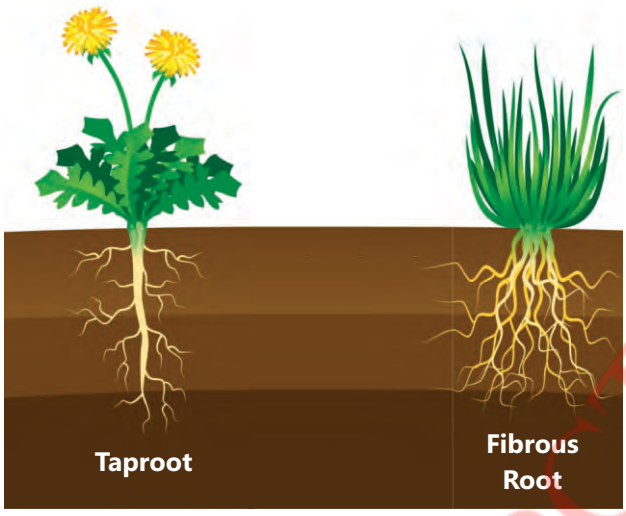

Figure 1.3 Taproot and fibrous roots

Internal structure of root

The main parts in the internal structure of root are epidermis, cortex, endodermis vascular bundles, i.e., xylem and phloem **(Figure 1.4)**. The arrangement of these parts are shown in a transverse section (TS) of the root. **(Figure 1.5)**.

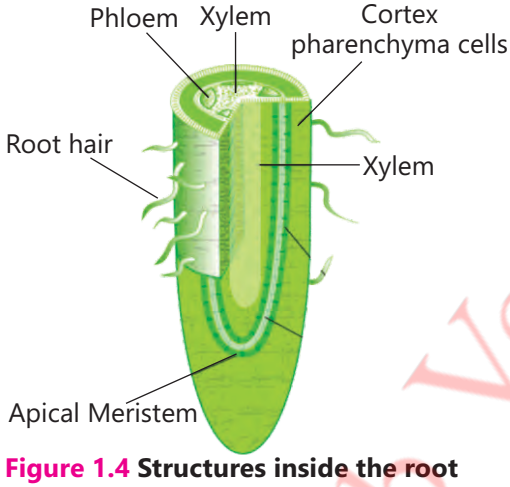

Figure 1.4 Structures inside the root

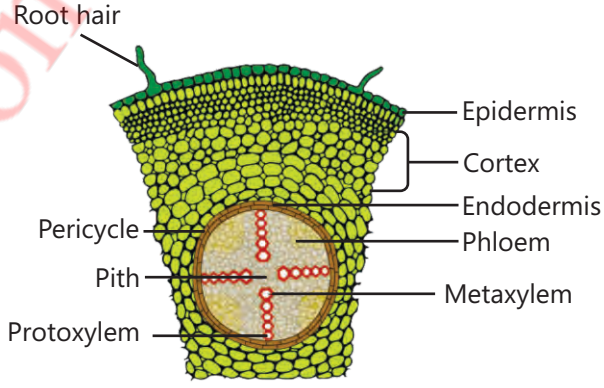

Figure 1.5 Internal structure of root

Epidermis

Epidermis is an outermost layer of thin walled cells having unicellular outgrowths called **root hairs**. Epidermis provides protection and helps in absorption of water and minerals from the soil.

Cortex

Inside the epidermis, many layers of thin walled and rounded cells form cortex. Water and minerals absorbed by root hairs in epidermis are transported towards xylem through cortex for onward conduction to leaves.

Endodermis

The innermost layer of cortex which consists of barrel shaped cells is called endodermis. It

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regulates the movement of water and hormones, etc., into and out of the vascular system.

Vascular system

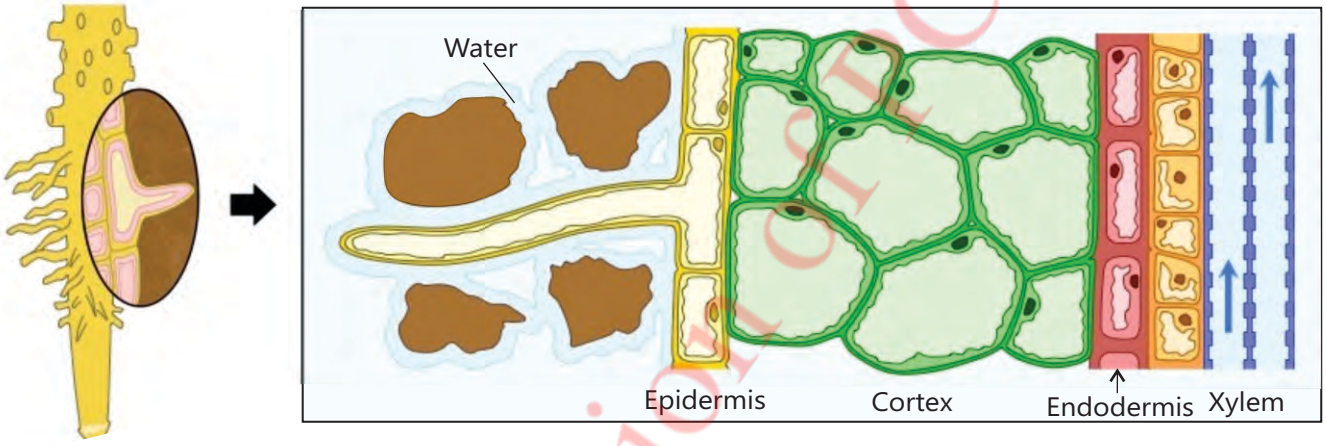
Xylem and phloem form vascular system. Xylem conducts water and minerals absorbed from roots to leaves through stem. Phloem transports food from leaves to roots and other parts of the plants.

Inquiry 1.1

Teacher Guide

Facilitate students conduct an interactive discussion of the following:

- Absorption of water and nutrients (minerals, etc.) by root hairs from soil and their diffusion towards xylem present in the centre of root.
- Conduction of water and dissolved minerals by xylem tissue from roots to leaves through stem.



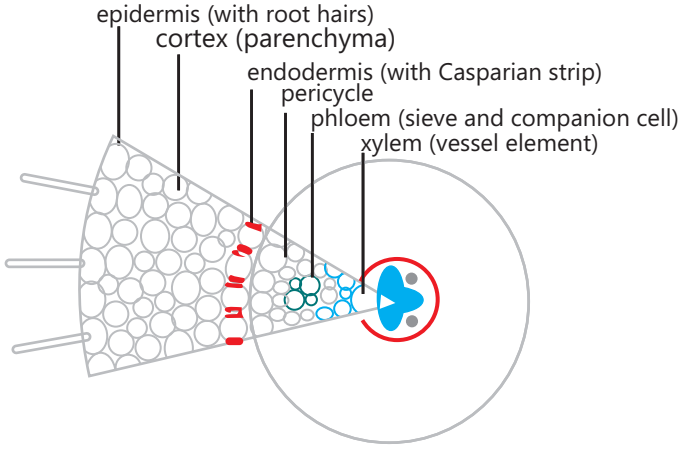
- Recall what you have learnt about diffusion.
- Do water and dissolved minerals (nutrients) move from soil to xylem tissue in the roots following the principle of diffusion through membranes of the cells in epidermis, cortex and endodermis, etc.?

Activity 1.2 Examining internal structure of root

Teacher Guide

Facilitate students:

- Take some herbaceous plant.
- Cut the transverse section (TS) of its root.
- Prepare a glass slide of the TS.
- Examine the TS under microscope.
- Identify different parts of the root.
- Draw an explanatory sketch of the TS.



1.1.2 Shoot System

The areal parts of the plants such as stem, its branches, leaves, flowers and fruit, etc., specialized for different functions make the **shoot system**. Here we will discuss stem and leaves.

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Stem

Stem is usually the aerial part of the plant. It provides support to its branches, leaves, flowers and fruit, etc. Vascular bundles (xylem and phloem) run through stem to leaves for transport of material within the plant body. A sketch of internal structure of stem **(Figure 1.6)** is self-explanatory with regards to the arrangement of different tissues in the plants.

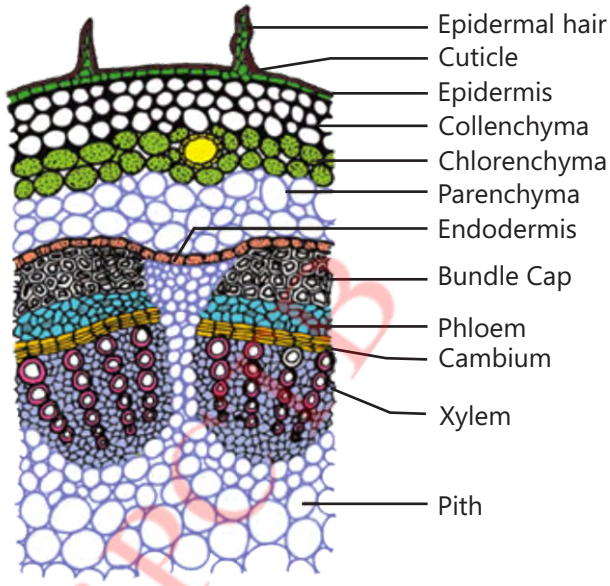

Figure 1.6 Internal structure of stem

Leaf

Stem and its branches bear leaves. Leaves are the organs which are well exposed to light and well adapted for preparation of food during photosynthesis. A leaf is provided with the stalk called **petiole**. Its flat green part is called **blade or lamina**, which has many veins. The middle strong vein is called **midrib (Figure 1.7)**.

Different shaped cells, as shown in the cross section of a leaf **(Figure 1.8),** perform different functions.

Figure 1.7 Leaf

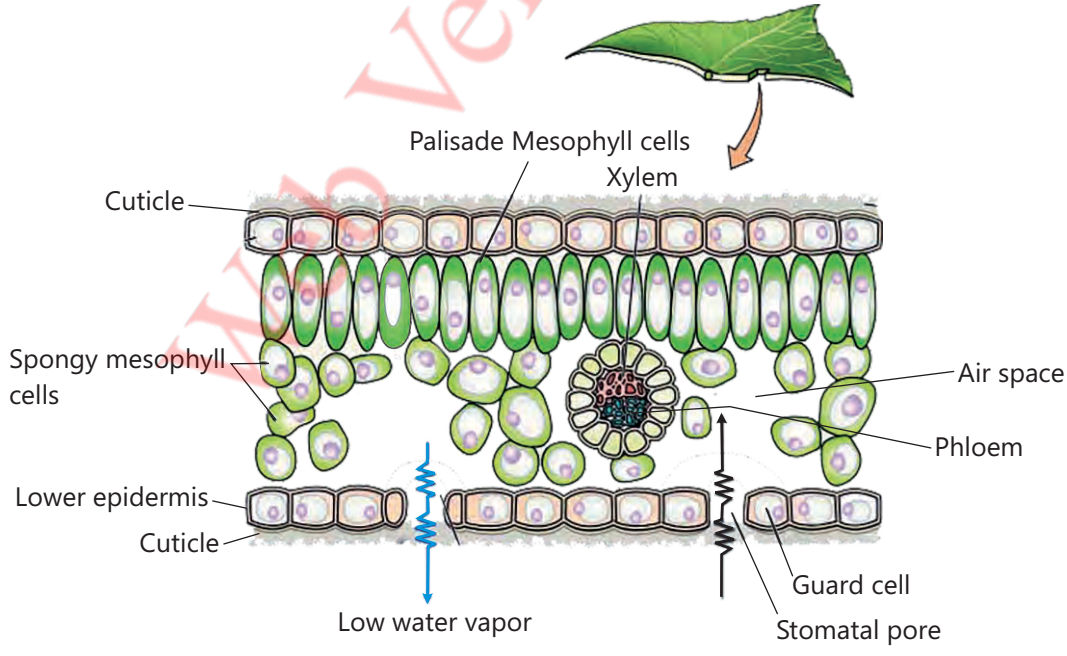

Figure 1.8 Internal structure of leaf

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Epidermal cells are tile-like and forming protective layers (upper epidermis and lower epidermis). Palisade mesophyll cells are elongated, spongy mesophyll cells are irregularly shaped having air spaces among them. Their function is to prepare food. Xylem tissue consists of tubular shaped cells used to conduct water. Phloem cells are also tubular in shape and used for transport of food. There are openings in the lower epidermis called stomata (sing. stoma). Each pore is surounded by a pair of guard cells. They allow exchange of carbon dioxide and oxygen. They also diffuse out water vapour.

1.1.3 Role of Xylem and Phloem in transport of water and food

Water and minerals diffuse from soil to roots and are conducted towards leaves through stem by xylem and the food prepared in leaves is transported to different parts of the plant through phloem **(Figure 1.9)**.

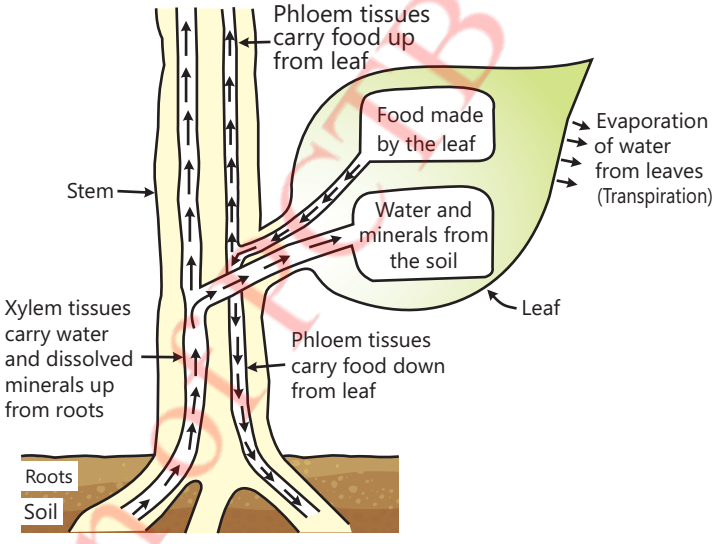
Phloem tissues carry food up from leaf
Food made by the leaf
Evaporation of water from leaves (Transpiration)
Stem
Water and minerals from the soil
Leaf
Xylem tissues carry water and dissolved minerals up from roots
Phloem tissues carry food down from leaf
Roots
Soil

Figure 1.9 Transportation of materials in plants

Do you know?

- Recall what you have learnt about solute, solvent, solution and diffusion of particles.
- The quantity of a solute dissolved in a given quantity of solution is termed as concentration.
- 1L sugar solution containing 3 teaspoonful of sugar dissolved in it, is more concentrated as compared to 1L sugar solution containing 1 teaspoonful of sugar dissolved in it.
- Solvent is the component of a solution which is present comparatively in large quantity.
- Water in the air is solute not solvent.

Conduction of water and dissolved minerals

Movement of material particles from the area where they are more to the area where they are less is called diffusion. The **diffusion** through membranes (like cell membranes) is called **osmosis**. As the concentration of water and dissolved minerals is more in soil as compared to the root cells, they move in the root tissue (osmosis). The xylem is a tissue in plants which forms a system of pipelines **(xylem vessels)** from roots to leaves through stem for the conduction of water, only in one direction **(Figure 1.10)**.

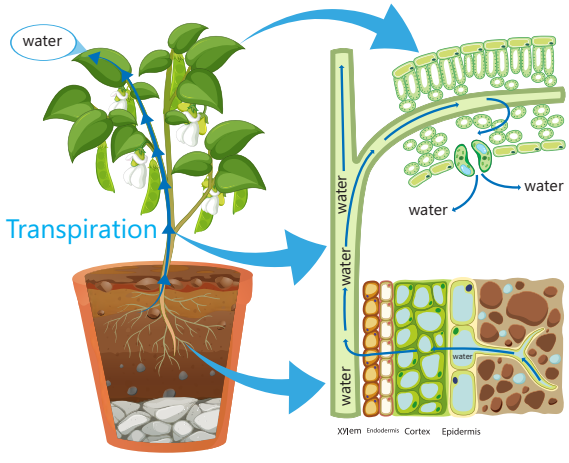

Figure 1.10 Conduction of water in plants

Transport of food (Translocation)

Food prepared by photosynthesis in leaves (carbohydrates, i.e., glucose, sucrose, etc.) enters the phloem **sieve tube elements** in dissolved form through **companion cells**. It is then transported

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to all other parts of plant body through phloem **(Figure 1.11)**.

Xylem tissue consists of dead cells joined end to end with no end walls to form a continuous tube. Phloem is composed of living cells called sieve tubes, companion cells and phloem parenchyma. **Parenchyma** is a type permanent tissue forming major part of ground tissue in plants. The main function of parenchyma is to store and assimilate food.

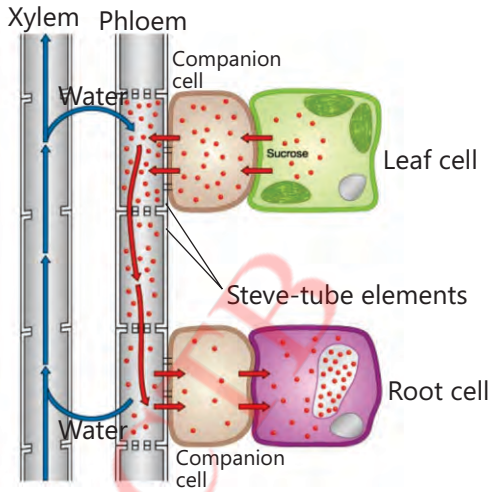

Figure 1.11 Transport of food in plants

Stomata

A large number of stomata **(Figure 1.12)** in lower epidermis of the leaf helps in absorption of carbon dioxide and release of surplus oxygen in the environment.

Figure 1.12 Stomata in leaves

Distribution of chloroplast in mesophyll tissue for maximum absorption of sunlight, regular supply of water through xylem tissue and carbon dioxide through stomata are the features of leaf that facilitate photosynthesis.

1.2 PHOTOSYNTHESIS

Photosynthesis is defined as the process during which carbon dioxide and water combine in the presence of sunlight and chlorophyll to form glucose (food) and oxygen.

Carbon dioxide + Water + Sunlight energy ⟶ Food (Glucose) + Oxygen

The process of photosynthesis depends on the following factors:

Light

Photosynthesis requires energy for combining carbon dioxide and water to form glucose (food). Sunlight provides this energy. The rate of photosynthesis depends upon the intensity of light. There is more light intensity at noon, so, the rate of photosynthesis is fast at the noon. In the evening or morning, the rate of photosynthesis is slower due to less light intensity. Photosynthesis

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stops at night, because, there is no sunlight at night.

Do you know?

Light consists of seven colours but chlorophyll absorbs blue and red light.

Carbon Dioxide

Air contains 0.35 to 0.4 % carbon dioxide. If there is more amount of carbon dioxide in the environment, the rate of photosynthesis will be fast, but once the carbon dioxide concentration reaches a certain level, there is no further increase in the rate of photosynthesis. Less quantity of carbon dioxide in an environment slows down the process of photosynthesis.

Water

Besides carbon dioxide, water is also an essential requirement for photosynthesis. If it is not available as much as require, the rate of photosynthesis will be affected and plant will produce less food.

Chlorophyll

The process of photosynthesis cannot take place without chlorophyll. It is only the chlorophyll which absorbs sunlight and makes it usable in the photosynthesis process. Chlorophyll is present in chloroplasts which are present in photosynthetic cells (mesophyll).

Temperature

Like many other chemical reactions, photosynthesis is also affected by temperature. The suitable temperature for this process is 25 – 35°C. At very high or very low temperatures, the process of

1.2.1 Adaptations in leaf structure for photosynthesis

1. The blades of leaves are flat and absorb maximum light required for photosynthesis.
2. Thin blades of leaves make the light and carbon dioxide reach the internal parts easily.
3. Thick layer of palisade mesophyll containing large number of chloroplasts just beneath the upper epidermis can make maximum absorption of light to make food for the plant.
4. Maximum air spaces among spongy mesophyll near the lower epidermis provide an easy passage for carbon dioxide to diffuse into cells containing chloroplasts to facilitate photosynthesis.
5. Numerous stomata in the lower epidermis absorb maximum carbon dioxide from the air needed for photosynthesis.
6. Division of vascular bundles into small branches spread throughout the leaf makes an easy and maximum water supply needed for photosynthesis.

Do you know?

- Photosynthesis takes place mainly in leaves; but, in some plants it occurs in green stems also. The process actually occurs inside the chloroplasts in the cells of leaves and stem.

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Scientific Investigation

Teacher Guide

Facilitate students to prove that photosynthesis occurs in the leaves

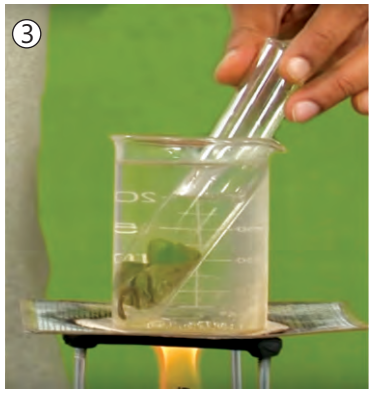
Background Information

Glucose made during photosynthesis is converted into starch which is stored in different parts of the plant including leaves. The presence of starch in a leaf proves that photosynthesis takes place in the leaf. The presence of starch in the leaf can be checked by iodine test.

Iodine Test

Iodine solution is yellow in colour. When one or two drops of iodine solution are added in starch solution, the colour of iodine solution changes to blue.

1. Fill a beaker (500mL) half with water, heat it till boiling and dip a green leaf in boiling water for 2 to 3 minutes.
2. Fill a test tube with alcohol up to its half. Remove the leaf from boiling water and dip it in alcohol .
3. Keep the test tube containing the leaf in boiling water for a few minutes, so that chlorophyll dissolves in alcohol .



4. Remove the leaf from alcohol and again dip it in boiling water so that it becomes soft.
5. Place the leaf in a dish and spread it.

6. Pour a few drops of iodine solution on the leaf with the help of a dropper.
7. You will see that the colour of the iodine solution becomes blue. This will prove that the starch is present in the leaf.

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Mineral nutrition in plants

Minerals are the chemical substances required by an organism for growth and other vital functions. Carbon, hydrogen, oxygen, nitrogen, magnesium, etc. are the nutrients required by plants in large quantities. Carbon, hydrogen and oxygen are obtained from carbon dioxide and water. The other nutrients like magnesium and nitrogen are obtained from the soil dissolved in water.

Magnesium

Magnesium is required by plants for the formation of chlorophyll. It is helpful for the functioning of enzymes to produce carbohydrates and fats. Its deficiency causes poor growth, yellowing and wilting of leaves.

Nitrogen

Nitrogen in the form of its compounds, (nitrates) dissolved in soil water, is required by plants for making chlorophyll and amino acids. Amino acids form proteins. Chlorophyll is necessary for photosynthesis. Proteins are necessary for growth, repair and other developments and defensive functions. Deficiency in nitrogen makes the leaves pale green or yellow. It affects the rate of photosynthesis and growth in plants.

1.3 RESPIRATION IN PLANTS

Respiration is defined as the process during which glucose (food) reacts with oxygen to produce carbon dioxide, water and energy required for survival of life.

Food (Glucose) + Oxygen ⟶ Carbon dioxide + Water + Chemical energy

Respiration takes place in all the cells of living bodies. The mitochondria which are found in the cells perform the process of respiration. For this reason, mitochondria **(Figure 1.13)** are called power house of the cell.

Importance of Respiration

Respiration is the only process which provides energy in usable form by living things. This process continues all the time in all kinds of living organisms. Stopping of respiration means death of the organism. In plants, the oxygen required for respiration comes from photosynthesis.

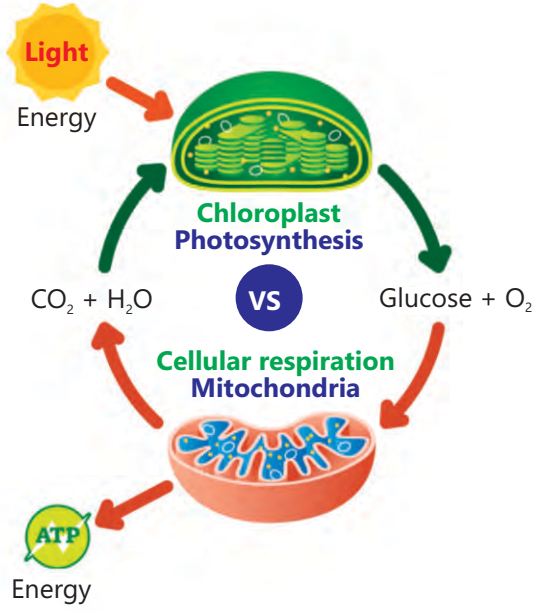

Figure 1.13 Comparison between photosynthesis and respiration

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Informative

- Plants absorb carbon dioxide and release oxygen during day time, whereas, at night, they absorb oxygen and release carbon dioxide.
- In plants, exchange of gases takes place through stomata, whereas, in the animals this work is performed by the lungs.

1.3.1 Comparison and Contrast between Photosynthesis and Respiration

1. Photosynthesis takes place in green plants, algae and some bacteria, whereas, respiration takes place in all the living things.
2. Photosynthesis takes place in chloroplasts, whereas, respiration takes place in mitochondria.
3. Photosynthesis uses sunlight energy to prepare food, whereas, respiration releases energy from food which is used for growth and performing all other body functions.
4. The **products** made during photosynthesis, i.e., glucose and oxygen are the **reactants** of respiration.
5. The products of respiration, i.e., carbon dioxide and water are the reactants of photosynthesis.

1.4 TRANSPIRATION

Plants continuously absorb water from soil through roots. The same is being conducted to leaves where it is used in photosynthesis. The excessive water is removed through stomata and from the aerial parts of the plants. The loss of water from aerial parts of the plants is called transpiration **(Figure 1.14)**.

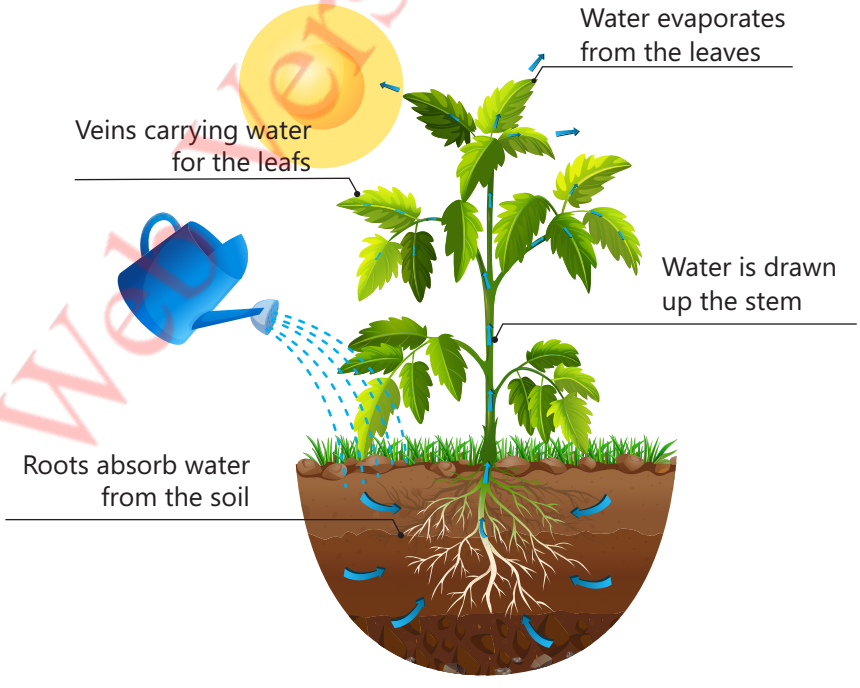
Water evaporates from the leaves
Veins carrying water for the leafs
Water is drawn up the stem
Roots absorb water from the soil

Figure 1.14 Transpiration in plants

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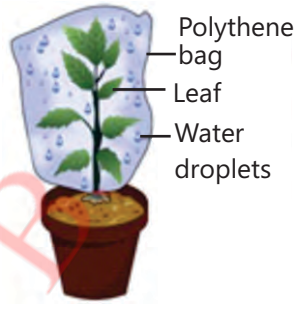
Activity 1.3 Transpiration in plants

- Take a potted plant and sprinkle water on the soil in the pot, where the plant is grown.
- Cover the plant with a transparent polythene bag.
- Tie the mouth of the bag around the base of the stem as shown in the Figure.
- Place the plant in sunlight for 4–5 hours.
- You will observe drops of water on the inner side of the polythene bag.
- Where do these water drops come from?



Conclusion:_____

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Capillary action

Very narrow glass tubes are called capillary tubes. Water moves up in the capillary tubes due to interaction between water molecules and surface of the tubes **(Figure 1.15)**. This effect is called **capillary action**.

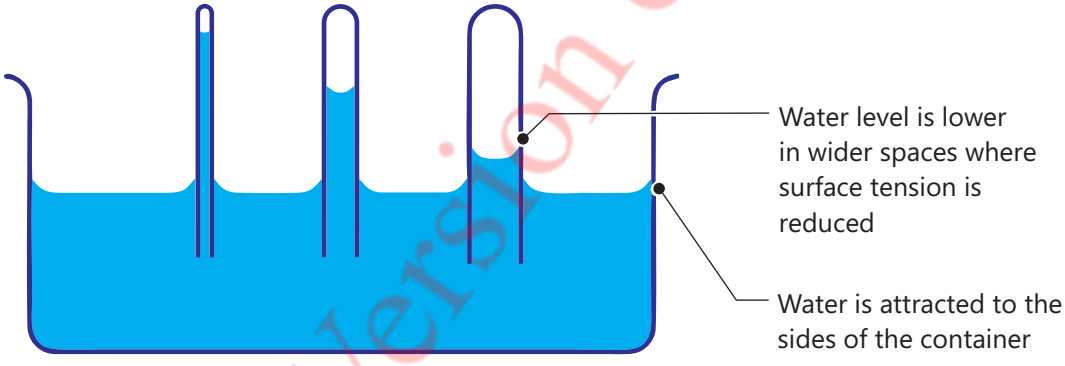

Figure 1.15 Capillary action

Capillary action in narrow xylem vessels in small plants helps water move up towards leaves.

Do you know?

- Water filled in a glass tube faces two types of forces. One is the attractive force between the molecules of water (intermolecular force) and the other is the force between the molecules of water and glass surface.
- The force between the molecules of water is termed as cohesive force, whereas, the forces between the water molecules and glass surface is termed as adhesive force.
- If the adhesive force is greater than the cohesive force, water rises up the tube through capillary action.
- In narrow tubes, the adhesive force becomes greater than the cohesive force which makes the water rise up the tubes through capillary action.
- Water rise up in xylem vessels is a natural example of capillary action.
- In narrow tubes, the adhesive force becomes greater than the cohesive force which makes the water rise up the tubes through capillary action.
- Water rise up in xylem vessels is a natural example of capillary action.

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1.4.1 Natural Raise of Water Based on Principle of Transpiration

Transpiration is the water escape from the pores in leaves or stems (stomata). It develops suction force in the xylem bundles, causing the water rise up. Tall trees having more surface area for transpiration cause strong suction force or transpiration pull on water in the xylem bundles. The increased transpiration pull in tall trees causes the plant to absorb more water.

Informative

Capillary action and transpiration pull are the causes of natural raise of water in the materials. Building materials such as bricks and concrete blocks, etc., when come in contact with moisture, water rises into their pores due to capillary action and makes the material damped. Water is also raised in the pores of paper and plaster. Wicking of paint between the hairs of a paintbrush and movement water through sand are also the examples in this regard.

Importance of transpiration

Transpiration pulls the water through air spaces in spongy mesophyll and keeps the mesophyll moist, which is essential for the exchange of gases. Effects of evaporation of water from leaves or stems are:

- cools the surface of the leaves and the surroundings as well,
- allows the movement of minerals from the soil to different parts of the plant,
- helps in growth and development.
- controls the temperature of the plants.

1.4.2 Factors Affecting the Rate of Transpiration

Wind, temperature, light and humidity are the main factors that affect the rate of transpiration.

Wind

The still air surrounding the plant leaves becomes humid and resists the diffusion of water from leaves into the air. It decreases the rate of transpiration. Wind sweeps the humidity away from leaves surroundings and increases the rate of transpiration.

Temperature

Rise in temperature provides more energy to the water molecules for evaporation from the leaves surfaces, hence, increases the rate of transpiration.

Light

In sunlight, the stomata remain open for removal of water through them. At night stomata are closed. In this way light also affects the rate of transpiration.

Humidity

Humid air surrounding the plants contains more amount of water, thus, decreasing the rate of diffusion of water molecules from plants leaves into air. It slows down the transpiration. The rate of transpiration is rapid in dry air.

Point to ponder

- Gravity does not affect the capillary action. Request your teacher to explain why?

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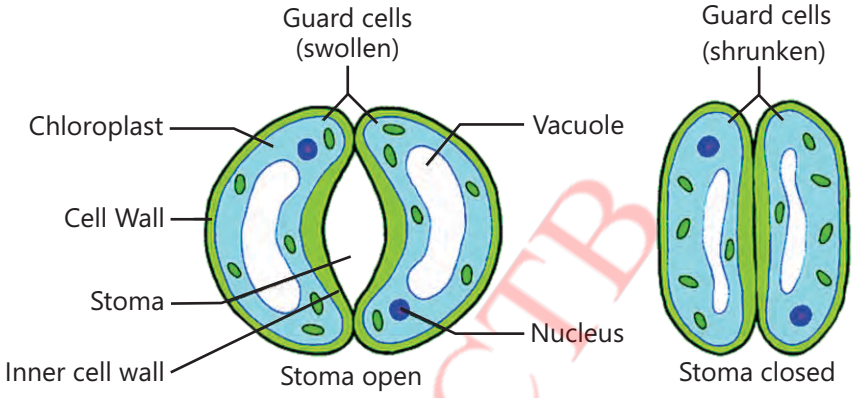
Informative

- When guard cells of stomata absorb water, they swell up and make the stomata open.
- When guard cells lose water, stomata are closed.
- Generally, stomata remain open during day time and are closed at night.



KEY POINTS

- Roots are the underground parts of the plants forming a system specialized for absorption of water and nutrients from the soil.
- Root hairs are thread like outgrowths of epidermal cells which increase the surface area for absorption of water and minerals.
- The areal parts of the plants such as stem, its branches, leaves, flowers and fruit, etc., specialized for different functions make the shoot system.
- Xylem and phloem form vascular system. Xylem conducts water from roots to leaves through stem. Phloem transports food from leaves to roots and other parts of the plants.
- Photosynthesis is process during which carbon dioxide and water combine in the presence of light and chlorophyll to produce food (glucose) and oxygen.
- Respiration is a process during which food (glucose) reacts with oxygen to produce carbon dioxide, water and energy.
- The loss of water from aerial parts of the plants is called transpiration.
- Wind, temperature, light and humidity are the main factors that affect the rate of transpiration.
- Capillary action and transpiration pull are the causes of natural raise of water based on the principle of transpiration.

QUESTIONS

1.1 Encircle the correct option.

(i) Water and dissolved salts are conducted from roots to leaves by:

a. root hairs b. xylem c. phloem d. stomata

(ii) The innermost layer of cortex in the root:

a. epidermis b. endodermis c. pericycle d. cambium

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(iii) What is required for photosynthesis in addition to light?

a. oxygen and carbon dioxide b. oxygen and water
c. carbon dioxide and water d. nitrogen and water

(iv) Oxygen and ---------- are the products of photosynthesis:

a. water b. carbon dioxide c. glucose d. chlorophyll

(v) The products of respiration are carbon dioxide and:

a. water b. oxygen c. mitochondria d. chloroplast

(vi) The loss of water from aerial parts of the plants:

a. respiration b. photosynthesis c. evaporation d. transpiration

(vii) Chlorophyll is present in:

a. mesophyll cells b. upper epidermis c. lower epidermis d. endodermis

(viii) Mineral required in the formation of chlorophyll:

a. iodine b. iron c. phosphorus d. magnesium

(ix) The force between the molecules of water:

a. adhesive force b. cohesive force c. repulsive force d. magnetic force

(x) Rate of transpiration decreases with the increase of:

a. temperature b. light intensity c. humidity in air d. wind speed

1.2 Give short answers.

1. What is primary root?
2. What is secondary root?
3. State the function of root cap.
4. Write word equation for photosynthesis.
5. Write word equation for respiration

1.3 Differentiate between:

1. Root system and shoot system
2. Xylem and phloem
3. Diffusion and osmosis
4. Epidermis and endodermis
5. Transpiration and evaporation
6. Capillary action and transpiration pull

1.4 Answer the following questions:

1. Describe the following in plants:
   (i) Photosynthesis (ii) Respiration (iii) Transpiration
2. Draw and label the internal structures of the following:
   (i) Root (ii) Stem (iii) Leaf
3. Compare and contrast the process of photosynthesis and respiration.
4. Describe the factors affecting the rate of transpiration.
5. Describe the importance of vascular bundles in plants.

1.5 Constructed Response Questions

1. Photosynthesis does not take place in animals but it is beneficial for animals also. How?
2. Plants produce food and oxygen during photosynthesis, which does not take place

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at night. Where do plants get oxygen from for respiration at night?

3. Why should not we sleep under tree at night?
4. How the structure of leaf is adapted to the process of photosynthesis?
5. Why is transpiration important for plants?
6. Describe the role of magnesium and nitrogen in plants nutrition.
7. Explore the natural raise of water based on the principle of transpiration.

1.6 Investigate:

(i) Function of the following in plants:

(a) Root hairs (b) Stomata (c) Spongy mesophyll

(ii) Internal structure and functions of the following in plants:

(a) root (b) stem (c) leaf

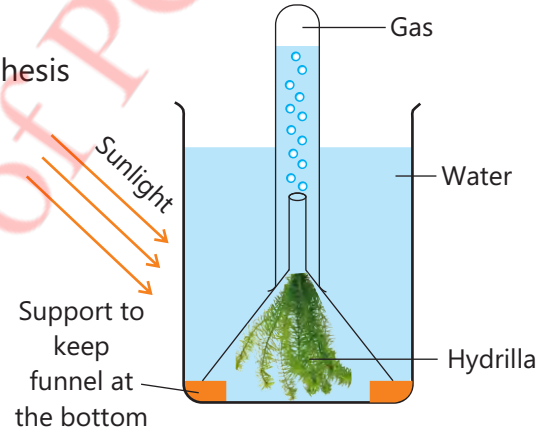
1.7 Project: (Scientific Investigation)

Prove that oxygen is produced by plants during photosynthesis

Teacher Guide

Facilitate students to conduct the experiment as under:

Procedure



1. Take a few twigs of hydrilla plant and insert them in a short stemmed funnel as shown in the Figure.
2. Place the funnel in a beaker containing water and provide support to keep the funnel at the bottom of the beaker.
3. Invert a test tube full of water over the stem of the funnel.
4. Make sure that the inverted test tube over the stem of the funnel remains fixed there.
5. To increase the amount of dissolved carbon dioxide in the water, a little quantity of sodium bicarbonate (backing powder) may be added in the beaker.
6. Carefully, place the apparatus in the sun for 2 to 3 hours.

Observation

- Gas bubbles liberated from the hydrilla plant reach the top of the inverted test tube.
- The gas displaces the water downwards.

Prediction

Gas reached the top of the inverted test tube stem is oxygen which is produced during photosynthesis in hydrilla in the presence of sunlight.

Test

Test the gas produced during the experiment by applying the test for oxygen as under:

Test for oxygen gas

The glowing splint on getting oxygen relights and bursts back into flame.

Conclusion:

.....

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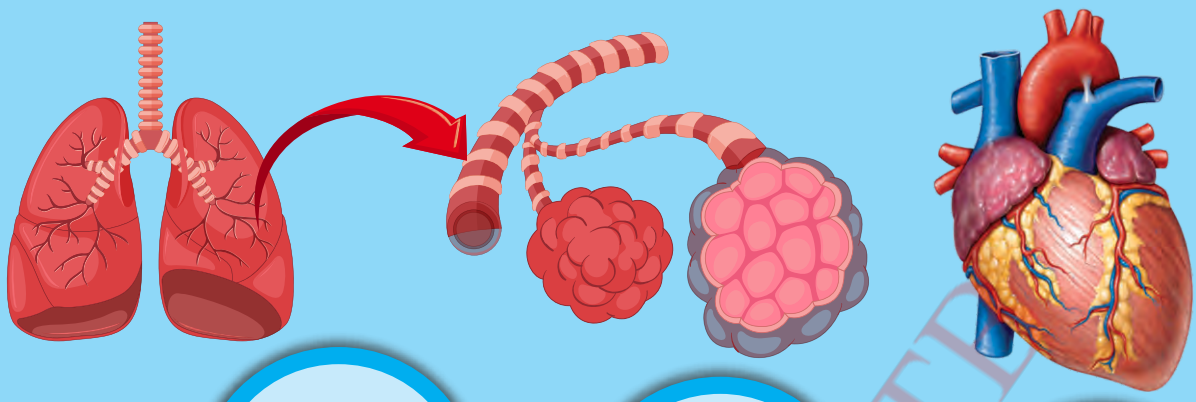

Where does oxygen react with food to release energy?

How are food and oxygen carried to the site of respiration?

Where do products of respiration go?

02 Human Respiratory and Circulatory SYSTEMS

Students' Learning Outcomes

After studying this chapter, students will be able to:

- Differentiate between the processes of respiration and breathing.
- Differentiate between aerobic and anaerobic respiration.
- Trace the path of air in and out of the body and how the oxygen it contains is used during the process of respiration.
- Sketch and label the human circulatory system.
- Hypothesize how exercises of varying intensity (from rest to high-intensity interval training) would impact their pulse rate, test their hypothesis, calculate their pulse rate and record their findings.
- Describe the role and function of major organs in the human respiratory system including trachea, lungs and alveoli (air sacs).
- Explain that living organisms have a complex transport system for transfer of various solids, liquids, and gases across the body.
- Describe the structure and function of the human heart.
- Explain how blood circulates in the human body through a network of vessels (arteries, veins and capillaries), and transports gases, nut1ients, wastes and heat.
- Compare and contrast arteries, veins and capillaries.
- Describe the composition of blood and the functions of red cells, white cells, platelets and plasma.

VOCABULARY

Inhalation	Exhalation	Respiration	Arteries	Veins	Capillaries
Breathing the air into lungs	Breathing the air out of lungs	Reaction of oxygen with food (glucose) to release energy	Vessels that carry blood from heart to other body parts	Vessels that carry blood back to heart from other body parts	Tiny branches of arteries for exchange of materials in body tissues

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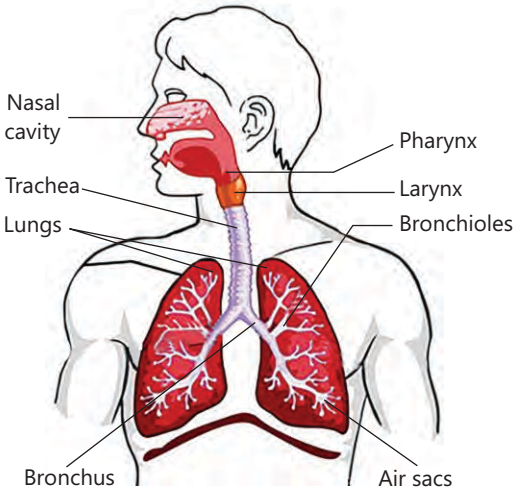
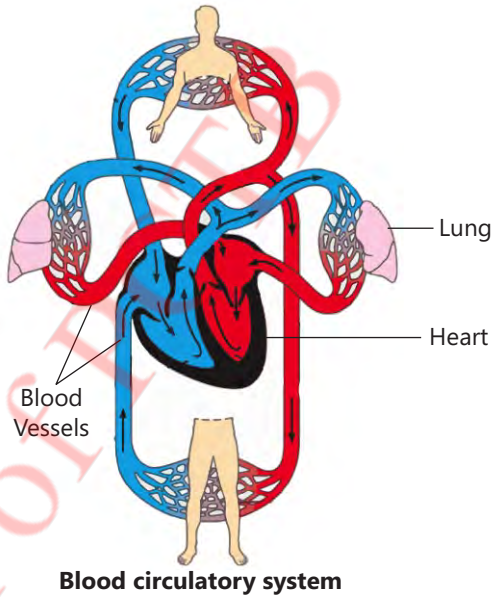
Recall what you have learnt

We have learnt briefly about:

- Human body organs, lungs and heart
- Gaseous exchange in lungs
- Blood circulation by the heart



Breathing system



Blood circulatory system

Figure 2.1 Breathing and blood circulatory systems

Activity 2.1 Assessment

Write **'C'** against the correct and **'I'** against the incorrect statement in the middle column. Also correct the incorrect statement and write it in the next column.

Correct/Incorrect	C/I	Correct statement
We breathe in, to get carbon dioxide.		
Chloroplasts are the cell organelles where food is oxidized to release energy.		
Cardiac muscles in the heart contract and relax to pump the blood and circulate it throughout the body.		
It is the chlorophyll which gives red colour to the blood.		

In this chapter we will learn about the following processes in human body:

- Breathing
- Respiration
- Blood circulation

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2.1 BREATHING

Air enters the body through the nostrils. The nostrils lead into **nasal passage** or **nasal cavity** (Figure 2.2). Dust and bacteria, etc., are trapped by the hair and mucus in the nasal passage. The air is also warmed and moistened in the nasal passage. From here, air is passed to windpipe or trachea through **larynx** or voice box. The opening of air passage in the larynx is called **glottis** which has a lid called **epiglottis**. The epiglottis prevents food from entering the trachea. Trachea divides into two tubes called **bronchi** (singular: **bronchus**). The bronchi carry air nto the lungs, one to each lung. The walls of the trachea and bronchi bear cilia and have mucus, which trap dust particles and bacteria. Inside the lungs, the bronchi branch into smaller tubes called **bronchioles**. Each bronchiole ends in a group of **air sacs** or **alveoli** (singular **alveolus**).The lungs look like sponges due to the presence of alveoli. Millions of alveoli are found in the lungs. They are surrounded by thick network of blood capillaries.

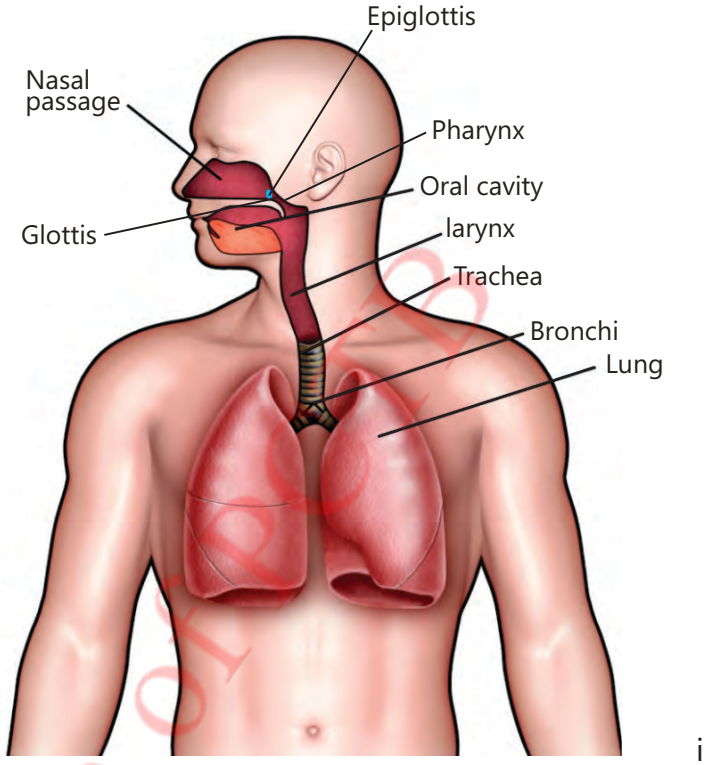

Figure 2.2 **Respiratory system in man**

Gaseous exchange takes place in the alveoli **(Figure 2.3)**. Oxygen from the air diffuses into blood through the walls of the alveoli. At the same time, carbon dioxide carried by the blood from the body cells diffuses out into the alveoli. From the alveoli, it passes out of the body. Blood during its circulation supplies each of the body cells with oxygen and collects carbon dioxide produced in the cells during oxidation of food.

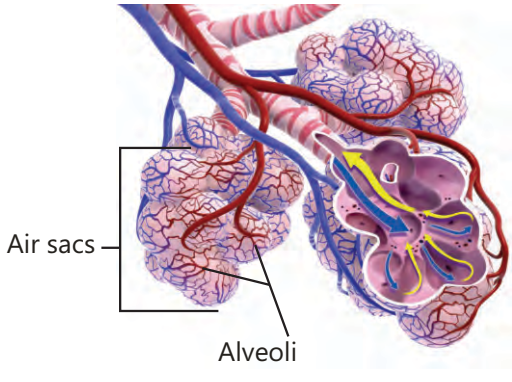

Figure 2.3 **Blood supply to alveoli**

Mechanism of Breathing

When we breathe in, rib muscles contract pulling the ribs up and out and chest cavity expands. At the same time, diaphragm contracts and flattens. The space inside the chest cavity becomes larger.

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As a result, air enters into the lungs. This is called inspiration. The reverse of this process is called expiration **(Figure 2.4)**.

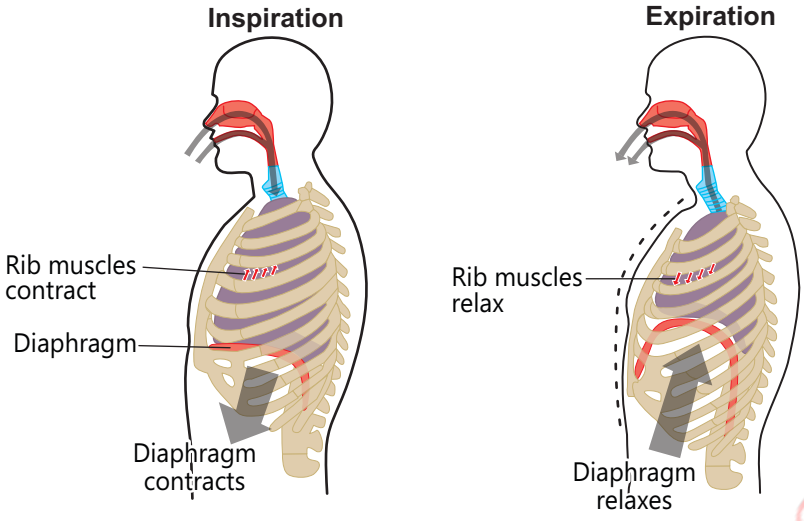


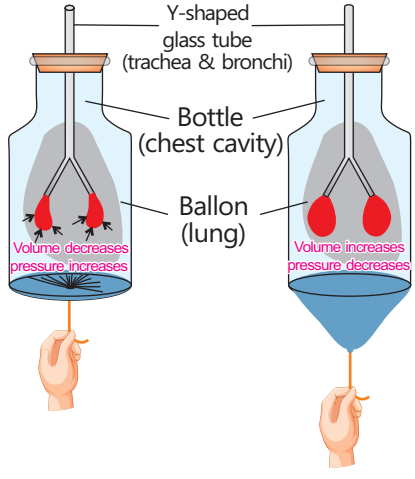
Figure 2.4 Mechanism of breathing

Activity 2.2

- Take a test tube. Pour lime water into it. Put a straw in the test tube. Now breathe out gently through the straw. Lime water in the tube bubbles when you breathe into it. Lime water becomes milky. It proves that carbon dioxide is given out during respiration.

Activity 2.3

- Take a plastic bottle. Cut its bottom. Take a Y-shaped glass tube. Bind a balloon at each of the forked ends of the glass tube as shown in the Figure. Pass stem of the tube through the hole in a cork. Fix the cork at the mouth of the bottle. Make it air tight with wax. The stem of glass tube represents the trachea, branch tubes are the bronchi, and balloons represent the lungs. The bottle represents the chest cavity.
- Take a large balloon and cut off its mouth. Stretch this balloon across the bottom of the bottle. Fix it with a rubber band or gum. Tie a thread or rubber band at the bottom of the stretched balloon sheath. The balloon sheath will represent the diaphragm.
- Can you predict what will happen to the internal balloons if you pull down the balloon sheath (diaphragm)?



Q. How is this model like an actual breathing system in our body?

The pathway that the air follows during inspiration and expiration for exchange of gases is shown in **Figure 2.5.**

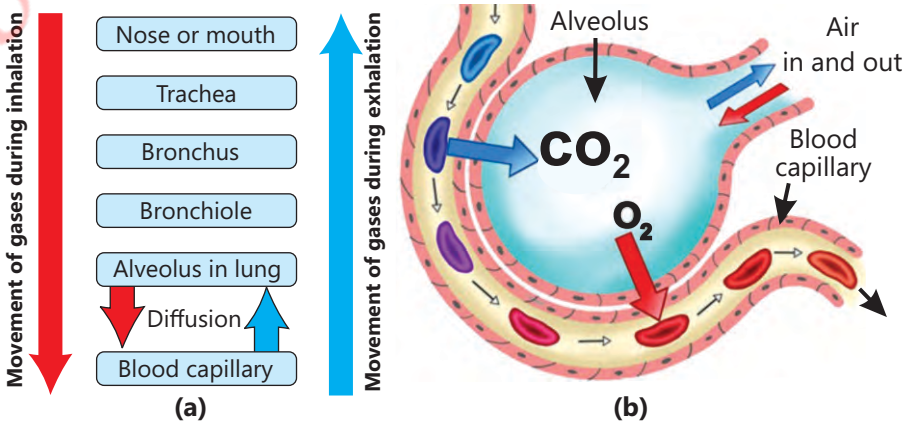


Figure 2.5 (a) Pathway of the air breathing in and out
(b) Gaseous exchange in an alveolus

Do you know?

- Total surface area of the alveoli in both the lungs has been estimated to be more than the whole area of your skin.

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2.2 RESPIRATION

Blood during its circulation, provides oxygen to every cell in the body. In the cells of our body, oxygen reacts with food (glucose) molecules to convert them into carbon dioxide and water along with the release of energy in the form of ATP (Adenosine triphosphate). The process is called respiration. The whole process of respiration is completed in a series of reactions, each of which is facilitated by a specific enzyme.

Respiration is of two types; aerobic respiration and anaerobic respiration.

2.2.1 Aerobic Respiration

The respiration process during which food is broken down to release energy in the presence of oxygen is called **aerobic respiration**.

$$C_6H_{12}O_6 + O_2 \longrightarrow CO_2 + H_2O + ATP$$

(Glucose) + (Oxygen) (Carbon dioxide) + (Water) + (Energy)

Aerobic respiration takes place in the mitochondria of the cells in all plants, animals and our own body cells.

2.2.2 Anaerobic Respiration

The breakdown of food substances in the absence of oxygen is called **anaerobic respiration**. This process releases energy less than aerobic respiration. Yeast respires aerobically in the presence of oxygen. It can also respire an aerobically in the absence of oxygen. The products of anaerobic respiration in yeast are ethanol, carbon dioxide and energy.

Glucose $\longrightarrow$ Ethanol (alcohol) + Carbon dioxide + Energy

Due to production of alcohol, the anaerobic respiration in yeast is also known as **alcoholic fermentation**.

Our muscles normally respire aerobically. When we run fast, enough oxygen is not available for the muscle cells to respire aerobically. Our muscles respire anaerobically. Lactic acid is the product in this reaction.

Glucose $\longrightarrow$ Lactic acid + Energy

Lactic acid thus produced is transported to liver which convertS it back into glucose.

Difference between aerobic and anaerobic respiration

Aerobic respiration	Anaerobic respiration
It takes place in the presence of oxygen.	It takes place in the absence of oxygen.
Large amount of energy is released in aerobic respiration.	Small amount of energy is released in anaerobic respiration.
Carbon dioxide and water are the products of aerobic respiration.	Lactic acid is produced in muscles. Ethanol and carbon dioxide are produced in yeasts.

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Informative

- Units for the measure of energy are joules (J) and kilojoules (kJ). The other commonly used unit to measure energy is calorie (cal) or kilocalorie (kcal).
- One gram glucose produces about 3800 calories of energy.

Do you know?

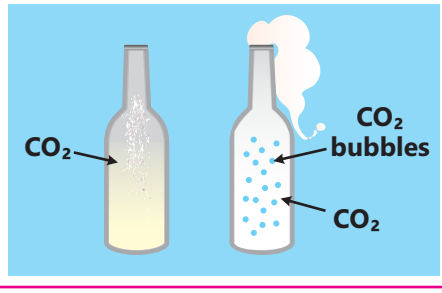
- A substance that speeds up a chemical reaction is called catalyst.
- The chemical reactions taking place In living bodies are called biochemical reactions.
- The catalysts of biochemical reactions are the enzymes which are special types of proteins.

Difference between breathing and respiration

Breathing	Respiration
Breathing is the exchange of gases by inhalation and exhalation of the air.	Respiration is a process to release energy from food during a series of reactions, each of which is catalyzed by a specific enzyme.
It takes place in alveoli of the lungs.	It takes place in mitochondria of the cells.
The purpose of breathing is to provide oxygen to all the body cells and getting rid of carbon dioxide produced in the cells.	The purpose of respiration is to provide energy to the whole body for carrying on the activities of life.
Rib muscles in the chest cavity and diaphragm play key role in inhaling and exhaling the air.	Muscles are not involved during the process of respiration.
Enzymes are not involved in breathing activity.	Enzymes are involved in all the reactions of respiration.

Activity 2.4

- Open the lid of a bottle containing fizzy drink.
- You will observe the chemical reaction taking place in the bottle.
- Add a little quantity of common salt in the bottle.
- What do you observe?
- Discuss the catalysts and their functions with your teacher and classmates.



2.2.3 Respiratory Diseases

The common respiratory diseases or disorders are common cold, pneumonia and asthma.

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Common cold

Common cold is the most common infectious disease of human respiratory system. It is a viral infection. Its symptoms are cough, sore throat, running nose, nasal congestion and sneezing. The best way to avoid this problem is thorough and regular washing of hands, getting rest and using liquids in diets. There is no proper medicine for common cold. If the symptoms persist, consult your doctor.

Pneumonia

It is another common illness which occurs in all age groups. Pneumonia is a lungs disease. It can be caused by bacterial, viral and fungal infections. The symptoms are cough, chest pain, fever and difficulty in breathing. During pneumonia, the alveoli are filled with a fluid (pus), which prevents oxygen from reaching the blood and makes breathing painful. Pneumonia is treated with antibiotics as advised by the physician.

As a preventive measure, wash hands frequently to avoid germs, use tissue paper or handkerchief while coughing or sneezing.

Asthma

It is a form of difficult breathing. Commonly, it is an allergic response of the body to substances like pollen, household dust, a particular food or feathers from pillow. A characteristic whistling sound is produced during breathing. Asthma can be avoided by keeping ourselves safe from pollen, household dust and feathers from pillow.

2.3 BLOOD CIRCULATION

Living organisms need essential substances in every cell to carry on its activities. They also need to get rid of the waste matters produced in each cell. In unicellular organisms, this is achieved simply by diffusion. In multicellular organisms, there is a need of transport system. Transport system can be defined as a system by which materials are carried from one part of the body to another.

A system that works for transport of materials in our body is called **circulatory system (Figure 2.6)**. The human circulatory system consists of heart, blood vessels and blood. Blood is a fluid which circulates throughout the body. The blood circulates in two types of vessels. One type of blood vessels (arteries) takes the blood out of the heart to all over the body. The other type of blood vessels (veins) brings the blood towards the heart from all over the body.

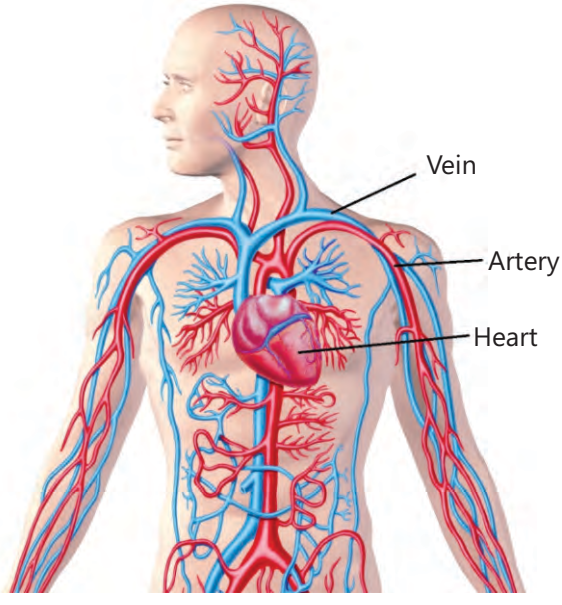

Figure 2.6 Circulatory System

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What is diffusion?

The net movement of molecules from a region where they are in higher concentration to a region where they are in lower concentration is called diffusion.

2.3.1 Heart

The organ that pumps the blood in blood vessels is called heart. Where is heart located? Put your hand on the upper left side of your chest. Do you feel something beating? The organ which is beating is your heart. What is the shape of the heart? The heart is somewhat cone-shaped **(Figure 2.7).** The size of human heart is about the size of the fist. It is present in the chest cavity between the two lungs. It is a muscular organ. The heart is enclosed in a thin double-layered transparent membrane called **pericardium**.

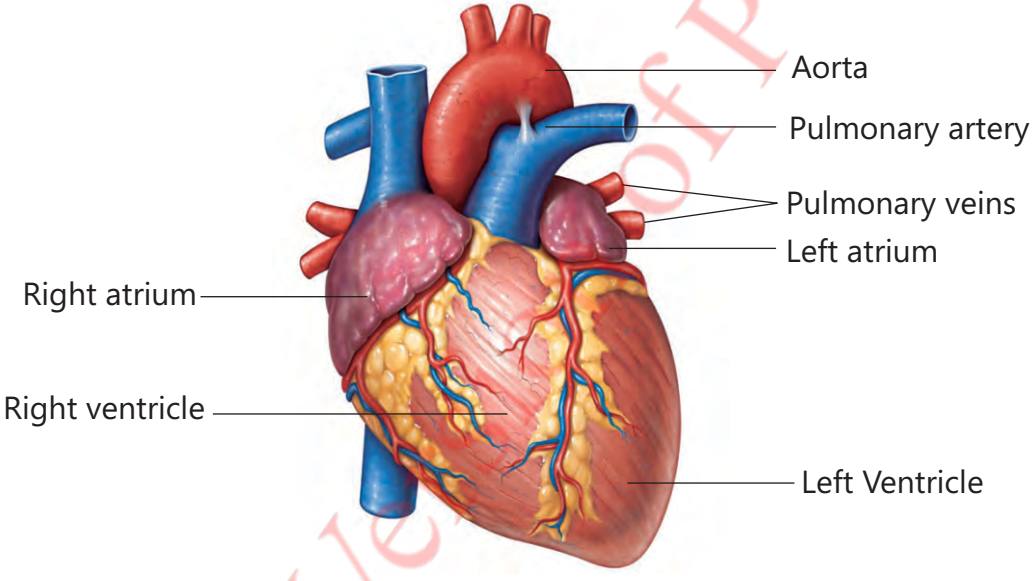

Figure 2.7 External structure of human heart

Internally, the heart consists of four chambers. The upper two chambers are called **atria** and the lower two chambers are called **ventricles**. The atria are divided into **left atrium** and **right atrium**. The ventricles are also divided into **right ventricle** and **left ventricle**. Atria are thin-walled chambers as compared to ventricles. Left ventricle is thicker than the right ventricle. The left atrium opens into the left ventricle. The right atrium opens into the right ventricle. The flow of blood from atria to ventricles is regulated by valves which prevent the backflow of the blood.

Working of Heart

The right atrium receives deoxygenated blood (blood with less oxygen) through two veins; one carrying blood from upper part of the body and the other from lower part of the body. The left atrium receives oxygenated blood (blood with more oxygen) from the lungs.

Both atria contract at the same time and pump the blood from left atrium to left ventricle and from

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right atrium to right ventricle. The two ventricles contract at the same time. During this contraction, the blood from left ventricle is pumped towards all the body parts (except lungs) through the main artery called **aorta** and the blood from right ventricle is pumped towards the lungs.

2.3.2 Blood Vessels

The blood vessels **(Figure 2.8)** that carry blood away from the heart are called **arteries**. Aorta is the main artery. It branches to form small arteries. The arteries branch again to form **arterioles**. The arterioles divide and become tiny vessels called **capillaries**. Capillaries provide a large surface area for the exchange of materials between the blood and the tissues. Capillaries re-unite to form small veins called **venules**. The venules join to form bigger veins. The veins carry blood back to the heart.

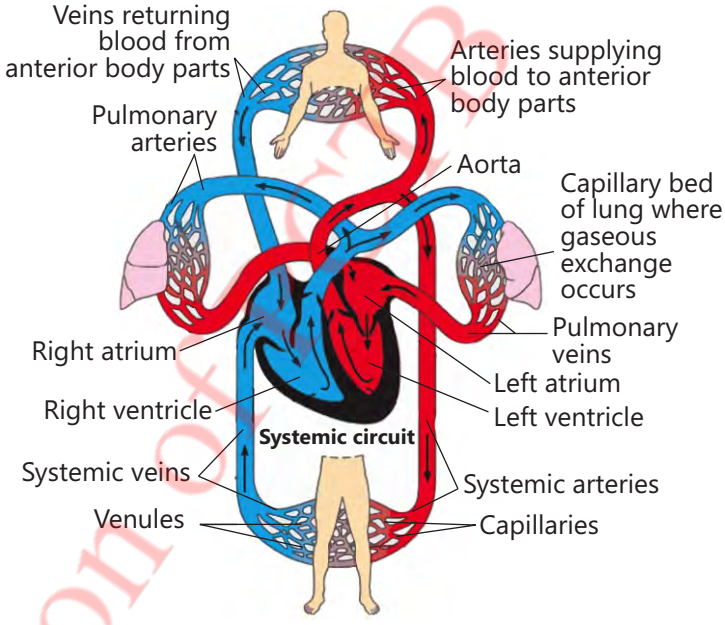

Figure 2.8 Structure and Function of Blood Vessels

Arteries are thick-walled. When an artery constricts, its lumen (space) becomes narrower and less blood flows through it in a given time. Arteries have no valves. In places where the arteries are close to the skin, such as wrist, one can feel the expansion of the arteries as pulse. The pulse tells us the rate of **heart beat**. The blood flows under high pressure in the arteries. When the blood reaches a vein, it flows slowly and smoothly. So the walls of the veins need not be as thick and muscular as those of the arteries.

Veins have larger lumen. Most of the veins have internal valves to prevent backflow of the blood. Capillaries are very thin walled vessels through which the exchange of materials between blood and tissues takes place.

Activity 2.5

- Observing blood vessels in human body.
- Touch your wrist along the line of the thumb. You will feel pulsating movement. This is a blood vessel called artery.
- Arteries are found deeply below the skin. The blood in the arteries is pulsating and pressure in them fluctuates with the heartbeat.
- Wrap a strap around your arm tightly and examine the arm carefully. You would observe bluish vessels just beneath the skin.
- These bluish vessels are the veins. They look bluish because they contain deoxygenated blood.
- Can you find blood vessels anywhere else in your body?

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Mini Exercise

What type of blood is received by right atrium. Oxygenated or deoxygenated blood?

Activity 2.6

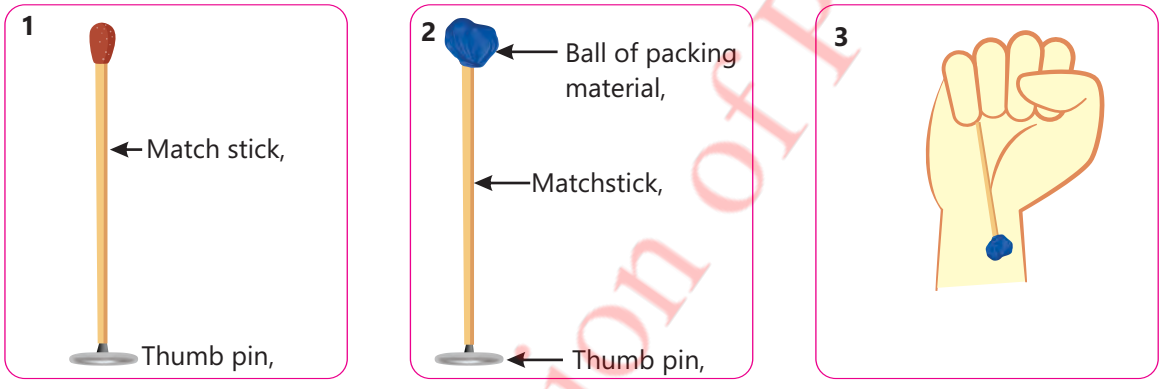
Making a Pulse Counter

- For the observation of artery, teacher will make and show small pulse counter to students.

Materials: Thumb pin, matchstick, cutter / knife, scotch tape.

Procedure:

1. Take a matchstick and wrap sticking tape around the base of the match stick. Insert the pointed end of the thumb pin into the base of the match stick.
2. Sharpen the head of the match stick and put a ball of packing material on it.
3. Put the finished product on the artery of the wrist. It will become a small pulse counter.



2.3.3 Comparison of Arteries, Veins and Capillaries

Arteries	Veins	Capillaries
Carry blood away from the heart	Carry blood towards the heart	Provide surface area for exchange of materials between the body cells and blood cells
Thick walled vessels	Thin walled vessels	Very thin walled
Facing high blood pressure	Facing low blood pressure	Facing low blood pressure
Having no valves	Veins have valve	No valve
Carry blood having oxygen and nutrients for the body cells, except pulmonary artery which carries deoxygenated blood.	Return blood carrying carbon dioxide and other wastes, except pulmonary vein which carries oxygenated blood	Provide oxygen and nutrients to the cells and collect carbon dioxide and other wastes from the cells.

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Activity 2.7 Measuring heart beat through pulse rate

- Press your index and middle fingers on inside of the wrist right below the base of the thumb and feel your pulse or the pulse of someone else.
- Count the beats you feel for one minute.
- Record the pulse rate (_____ beats per minute).
- Repeat the activity twice more, take an average pulse rate and record it in the chart.
- Take exercise by running for 2 – 3 minutes and observe the pulse rate immediately after exercising.

Pulse rate per minute

Time	1st count	2nd count	3rd count	Average
Before exercise				
After exercise				

Scientific Investigation

Teacher Guide

Facilitate the students to investigate and conduct an interactive discussion on the following:

1. What is cholesterol, its sources and effects on human health?
2. How does physical exercise keep you fit and healthy?

Scientific Investigation

Teacher Guide

Facilitate the students to investigate the carriers in science related to respiratory system such as respiratory therapists, pulmonologists, etc.

Respiratory therapists have an advanced knowledge of healthcare for human lungs and breathing system. They can examine your breathing system, diagnose and treat problems, recommend exercises and monitor progress.

Pulmonologists are the specialists of chest and respiratory problems. They can assist and treat patients of pneumonia, tuberculosis, asthma and other chest related issues.

2.4 BLOOD

Our blood is 55 % plasma and 45 % blood cells suspended in the plasma. Plasma is 92 % water. Plasma without fibrinogen (blood clotting proteins) and blood cells is called serum.

Blood cells

Blood cells are of three cells (RBCs), white blood platelets **(Figure 2.9)**.

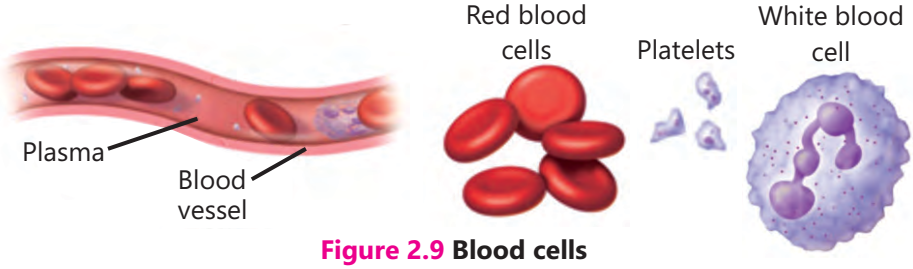

Figure 2.9 Blood cells

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Red blood cells (RBCs)

Red blood cells (RBCs) are disc shaped and slightly concave on both sides They contain haemoglobin (a red coloured protein) which gives them red colour. This is the haemoglobin in the red blood cells which carries oxygen from the lungs and supplies it to all the body cells during blood circulation. Haemoglobin also carries carbon dioxide from the blood cells and leaves it at the lungs for its removal from the body. Red blood cells exist for 120 days in the blood stream. They are finally fragmented in the liver.

White blood cells (WBCs)

White blood cells (WBCs) are colourless. They have no coloured pigment. They are part of the body's immune system. They help the body fight infection and other diseases. There are five types of white blood cells which are different in their structure and function. These are larger in size than the red blood cells. Their main function is to protect the body from disease causing microorganisms (pathogens).

Platelets

Platelets are not complete cells. These are fragments of cytoplasm enclosed by membranes. Platelets play an important role in blood clotting. They also help to slow or stop bleeding and healing wounds.

Informative

If there is an injury or cut in our body, platelets break apart and release a special chemical that works with proteins in the plasma and produce a web which traps red blood cells. The trapped red blood cells then dry and form a scab on injured site.

2.4.1 Disorders of Human Transport System

There are several disorders of human transport system, but we shall discuss heart attack and hypertension in this unit.

Heart Attack

A heart attack is the death of the part of heart muscle due to lack of blood supply. Coronary arteries supply blood to the heart. If a blood clot is made in coronary artery, it may block coronary artery. As a result, blood as well as oxygen supply to the heart is blocked. This condition leads to death of heart muscles.

In his situation, suddenly, the person feels discomfort or intense pain in the centre of chest. The pain may spread to shoulders, arm, neck or jaw. Other symptoms of heart attack include shortness of breath, sweating, and fainting. Coronary bypass is widely used surgical process to remove the blockage in coronary arteries.

Hypertension

Blood pressure is the force, blood exerts on the walls of arteries or veins in the body. Prolonged high blood pressure is called hypertension. During hypertension, the heart has to pump the blood harder. Obesity and lack of exercise lead to hypertension. Increase in rate of heart beat, sweating, discomfort and sinking of heart are the common symptoms. Weight loss, regular exercise, healthy food and medication can prevent hypertension.

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KEY POINTS

- Inhalation and exhalation of air is called breathing
- Respiration a process during which energy is released from food in series or reactions, each of which is catalyzed by a special type of enzyme.
- Respiration which takes place using oxygen is called aerobic respiration. Respiration which takes place in the absence of oxygen is called anaerobic respiration.
- Circulatory system consists of heart, blood vessels and blood.
- Blood vessels that carry blood from heart to other parts of the body are called arteries.
- Blood vessels that bring the blood back to heart from the other body parts are called veins.
- The tiny blood vessels which provide surface in the body tissues for exchange of materials between blood cells and body cells are called capillaries.
- Our blood is 55 % plasma and 45 % blood cells suspended in the plasma. Plasma is 92 % water.
- Plasma without fibrinogen (blood colouring proteins) and blood cells is called serum.
- Blood cells are of three types, i.e., red blood cells (RBCs), white blood cells (WBCs) and platelets.

QUESTIONS

2.1 Encircle the correct option.

1. Exchange of gases takes place in:

a. lungs b. bronchioles c. alveoli d. blood

2. Trachea divides into two :

a. bronchi b. veins c. villi d. ribs

3. The part of the heart which receives blood from lungs:

a. left atrium b. right atrium c. left ventricle d. right ventricle

4. Left atrium opens into:

a. right atrium b. right ventricle c. left ventricle d. aorta

5. Right atrium receives:

a. oxygenated blood b. deoxygenated blood
c. both types of blood d. no blood

6. Blood vessels that carry blood away from the heart are:

a. capillaries b. veins c. arteries d. venules

7. Aerobic respiration takes place in:

a. mitochondria b. chloroplasts c. nucleus d. blood vessels

8. Products of anaerobic respiration in yeasts are -------- along with energy:

a. carbon dioxide and water b. ethanol and carbon dioxide
c. oxygen and water d. lactic acid and water

9. Exchange of material in the body tissues and blood takes place in:

a. aorta b. ventricles c. veins d. capillaries

10. Which of the following plays an important role in blood clotting?

a. red blood cells b. white blood cells c. platelets d. bone cells

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2.2 Differentiate between:

1. Aerobic and anaerobic respiration
2. Oxygen and carbon dioxide
3. Breathing and respiration
4. Arteries and veins
5. Capillaries and alveoli

2.3 Give short answers.

1. Name the body parts involved in breathing system.
2. Name the products of anaerobic respiration which occurs in muscles.
3. Name different blood cells.
4. Where does blood oxygenate?
5. Name different chambers of human heart.

2.4 Answer the following questions.

1. Describe the functions of different valves in human heart and veins.
2. How does human heart work?
3. Explain the structures and functions of the following
   (a) Arteries (b) Veins (c) Capillaries
4. Explain the role of chest and rib muscles in breathing system.
5. Describe the composition of blood.

2.5 Constructed Response Questions

1. Explain the difference between burning and respiration.
2. Blood circulatory system plays a key role in cellular respiration. Explain how?
3. Anaerobic respiration occurs when the body cannot get enough oxygen for aerobic respiration to take place. Explain with example of the situation when and where anaerobic respiration takes place in human body.

2.6 Project:

Investigate the heartbeat of your ten friends in terms of feeling pulse rate as under:

- Counting pulse per minutes

Sr. #	Name	1st count	2nd count	3rd count	Average
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

- Is the pulse rate of all of your friends same?
- If it is different, explain why?

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Germs causing diseases are found everywhere in our surrounding.

Harmful viruses and bacteria enter our body when we eat, breathe or touch our surrounding.

What makes us safe from diseases?

03 Immunity and Diseases

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Students' Learning Outcomes

After studying this chapter, students will be able to:

- Explain various lines of defences that the body has against pathogens.
- Describe the three types of immunity in humans; innate, adaptive, and passive.
- Identify the various types of pathogens that cause infectious diseases.
- Describe the parts of the immunity system and how they function to produce an immune response.
- Illustrate how adaptive immunity develops overtime.
- Visualize the ways to add additional layers of defence (such as wearing masks, using sanitizers, etc.).
- Propose some common strategies for strengthening their immune system.
- Explain how infectious diseases such as hepatitis, covid-19, typhoid, and dengue are caused, how they are tested and diagnosed, and how they can be prevented.
- Suggest ways in which communities of people can safeguard against the spread of infectious diseases.

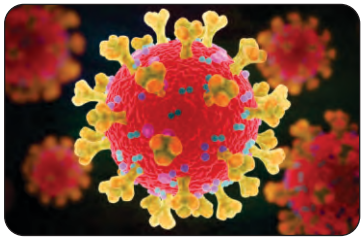
VOCABULARY

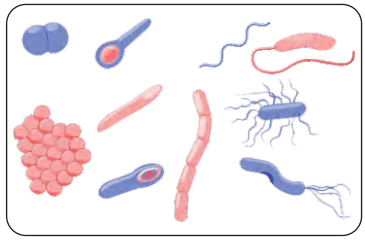
Immunity	Infection	Antibodies	Pathogens	Parasite
Ability of an organism's body to defend itself against disease-causing organisms	Entry and growth of microorganisms into bodies of other organisms	Proteins that protect human body when an unwanted substance enters it	Disease causing microorganisms	An organism living in the body of another organism for food that may cause diseases

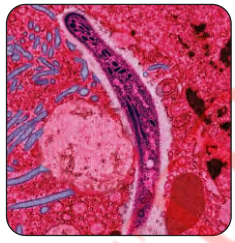
Recall what you have learnt:

We have learnt about the following:

- Viruses and microorganisms that cause diseases **(Figure 3.1)**


Virus


Bacteria


Plasmodium

Fungus

Figure 3.1 Disease causing agents

- Contagious diseases
- Non-contagious diseases
- How can we avoid diseases?
- Prevention of diseases

Activity 3.1 Assessment

Write **'C'** against the correct and **'I'** against the incorrect statement in the middle column. Also correct the incorrect statement and write it in the next column.

Correct/Incorrect	C/I	Correct statement
Diseases that can be transmitted from one person to another are called contagious diseases.		
Diseases that are not transferred from one person to another are called contagious diseases.		
Cancer and diabetes are the examples of contagious diseases.		
Flu, polio, TB, COVID-19 and hepatitis are the examples of non-contagious diseases.		
Vaccination is a method of keeping us safe from a disease by injecting weak or killed germs of that disease into our body.		
Wearing mask can allow germs enter into our body from environment through nose and mouth.		
Penicillin was the first antibiotic		

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Inquiry 3.1

Teacher Guide

Facilitate students:

- Conduct an interactive discussion on the following:
  - (a) What do you think about the disease shown in the picture and how can it be avoided?
  - (b) What is antibiotic?
  - (c) Penicillin was the first antibiotic derived from a fungus known as **Penicillium**.
- What do you conclude from the discussion?

(a) _____

_____

_____

(b) _____

_____

(c) _____

_____

3.1 LINES OF DEFENCE AGAINST PATHOGENS

Microorganisms that cause diseases in human body are called **pathogens**. Entry and growth of pathogens into our body is called **infection**. Pathogens are found everywhere in our surrounding. They enter our body when we breathe, eat, touch surrounding and through injuries. What makes us safe from their harmful effects? The answer to this question is **physical barriers** and **immunity**.

3.1.1 Physical Barriers

Our skin, mucous membranes, hairs, cilia, saliva, etc., make the first line of defence against infections. They act as barriers to the entry of foreign organisms into body cells. Human skin has an outer multilayered thick cover of mostly dead cells called epidermis. The dead cells of **epidermis** keep on shedding **(Figure 3.2**) and expelling the pathogens away from skin. A pigment called **melanin** is present in epidermis. It darkens skin and protects us from harmful effects of sunlight.

Figure 3.2 Shedding of dead cells from human skin

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The moist linings of body organs / cavities like mouth, nose, lungs, stomach, etc., are the membranes which produce a thick fluid called **mucus**. These linings are thus called mucus membranes. The mucous traps foreign organisms (pathogens) and stops their entry into the body cells.

The **hairs** in nose filter out the dust, pollutants and microbes, etc., from the air breathed into trachea and lungs. **Cilia** lining the nostrils, nasal cavity and pharynx send these particles to digestive system. **Saliva** in the mouth (oral cavity) has antiseptic properties and kills the microorganisms in the food. It also washes the teeth and oral cavity. Constant blinking of eyes and **tears** also flushes and wipes away the pathogens.

3.1.2 Chemical Barriers

Acidity of skin secretions inhibits the bacterial growth. **Gastric juice** secreted by the linings of stomach walls contains **hydrochloric acid** which kills the pathogens present in the food.

An enzyme '**lysozyme**' produced in tears, perspiration and saliva breaks the bacterial cell wall which leads to their death.

Sebum is an unsaturated fatty acid in the perspiration. It provides a protective film on the skin which inhibits growth of microbes on the skin.

3.1.3 Nonspecific Defence

Nonspecific defence includes phagocytosis, inflammatory response, fever and complementary reactions, etc.

Phagocytosis

Phagocytosis is a cellular process of ingesting and eliminating foreign substance and microorganisms. A type of white blood cells called phagocytes perform this function. **(Figure 3.3)**.

Figure 3.3 Phagocytosis

Inflammatory response

When a body tissue is damaged or injured, it causes **inflammation**. Heat or burning effect, pain, redness, swelling, loss of function, etc., are the signs of inflammation. Inflammatory response is a part of the body's defence mechanism in which special cells called inflammatory cells are sent at the affected site. They remove the harmful foreign substances / pathogens from the site and begin the healing process.

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Informative

Interferon is a chemical secreted by infected cells helping against the pathogens.

3.2 IMMUNITY or SPECIFIC DEFENCE

The pathogens like virus, bacteria, fungi, toxins, etc., cause the body to produce special proteins called **antibodies.** Antibodies are produced by lymphocytes, in response to antigens present on pathogens. The antibodies work to destroy only those antigens which stimulate their production. After production, an antibody identifies the antigen, develops a lock and key relationship with it and neutralizes it **(Figure 3.4)**. As the antibodies work against particular antigens, the defence system so developed is called **specific defence**.

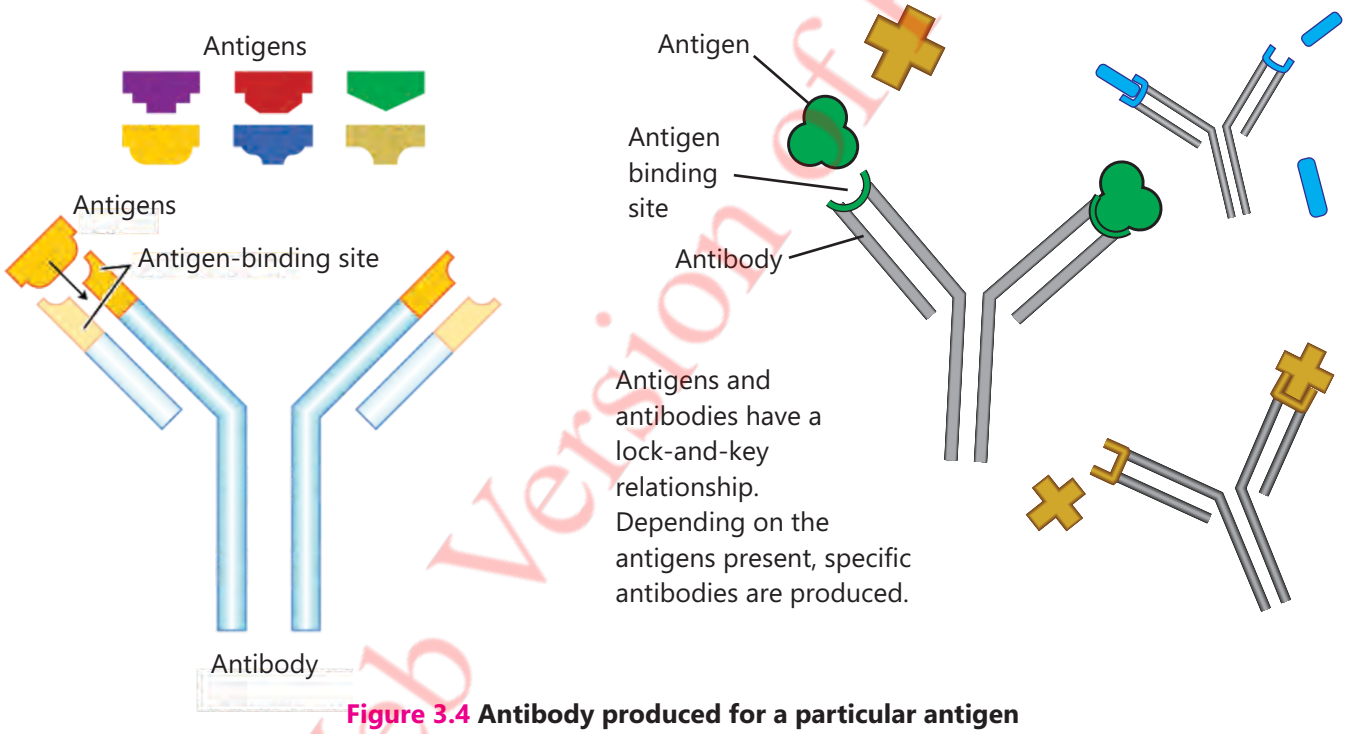

Figure 3.4 Antibody produced for a particular antigen

Two types of white blood cells called **B-lymphocytes** and **T-lymphocytes** are involved in immunity production.

B-lymphocytes show response by production of antibodies and antitoxins. This is called **humoral response**. T-lymphocytes directly fight with pathogens to remove them from body. It is called **cell-mediated response**.

3.2.1 Types of Immunity

Innate immunity

The **innate immunity** is inherited from parents and protects the individual since birth. It is always

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present in the body and generates a rapid response. It exhibits less potency. Innate immunity generates a non-specific immune response. Redness and swelling caused by white blood cells around a wound is an example of innate immunity **(Figure 3.5)**.

Figure 3.5 Redness and swelling around a wound

3.2.2 Adaptive immunity

The immunity acquired by an individual after the birth is called **adaptive immunity**. It is developed in response to external factors. It generates a delayed response in 5 – 6 days. It exhibits higher potency and produces specific immune response. Vaccination against a virus is the example of adaptive immunity **(Figure 3.6)**.

Figure 3.6 Vaccination against a virus

Adaptive immunity is again of two types, active immunity and passive immunity.

Active immunity

Active immunity is a type of adaptive (acquired) immunity by which a body produces its own antibodies in response to the pathogens entered in the body. Active immunity takes time in producing antibodies and giving response. It is more effective and long lasting. In order to acquire active immunity against a disease, weak or dead pathogens of the said disease are injected in the body in the form of vaccine **(Figure 3.7)**.

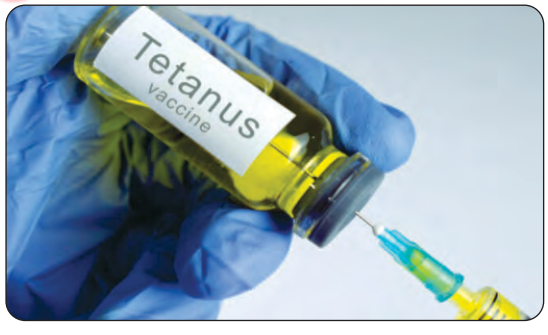

Figure 3.7 Tetanus vaccine

Passive immunity

Passive immunity is a type of adaptive (acquired) immunity by which readymade antibodies are transferred to the individual. Passive immunity is fast in providing immediate response. It is less effective and not long lasting. Immunity produced by the antibodies present in mother's milk is the example of passive immunity **(Figure 3.8)**.

Figure 3.8 Passive immunity

3.3 PATHOGENS CAUSING INFECTIOUS DISEASES

Infectious diseases are those which are caused by the entry and growth of pathogens in the body of an individual. Viruses, bacteria, fungi and other parasites are the pathogens causing infectious diseases.

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3.3.1 Viruses

Viruses are tiny particles which can cause infectious diseases. A complete virus is composed of the genetic material called **genome** covered by a **coat** called **capsid**. In some cases an additional coat called **envelope** is also present around the capsid **(Figure 3.9)**. Capsid is the protective coat made of **proteins**. Envelope, where present, is often covered with **spikes** that help to identify the host cell.

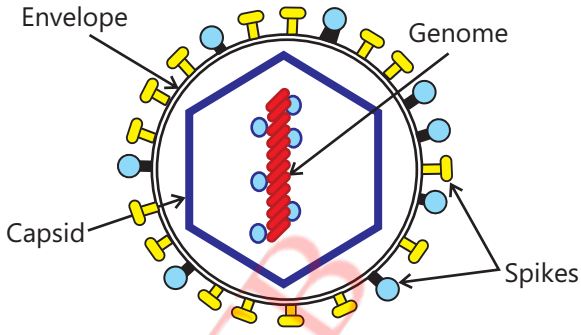
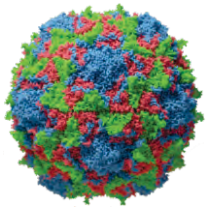
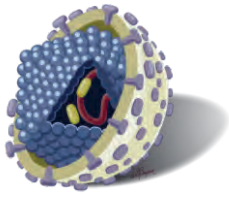
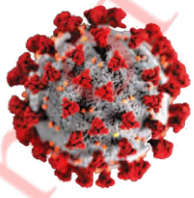


Figure 3.9 A typical enveloped virus

A virus after invading a host cell uses components of the host cell and replicates rapidly for producing more and more viruses of its own kind. On completion of replication cycle, the new viruses damage the host cell and are released to invade the other cells of the host body. In this way, the host cells are damaged and destroyed rapidly. The diseases caused by viruses in human are AIDS, COVID-19, hepatitis, polio, common cold, measles, etc. **(Figure 3.10)**.


Polio virus


Hepatitis B virus


COVID-19 virus

Smallpox virus

Measles virus

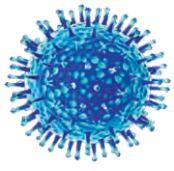

Common cold virus

Figure 3.10 Viruses causing different diseases

Informative

- Antibiotics do not kill viruses and therefore are ineffective as a treatment for viral infections.
- Antiviral medications can sometimes be used depending on the type of virus.

3.3.2 Bacteria

Bacteria are single celled microorganisms found in every type of environment. A bacterial cell is simply a **nucleoid or DNA** without any nuclear membrane present in the cytoplasm surrounded by a plasma membrane and an outer protective cell wall. Some bacteria have protective capsule over the cell wall **(Figure 3.11)**. Ribosomes are the sites for protein synthesis.

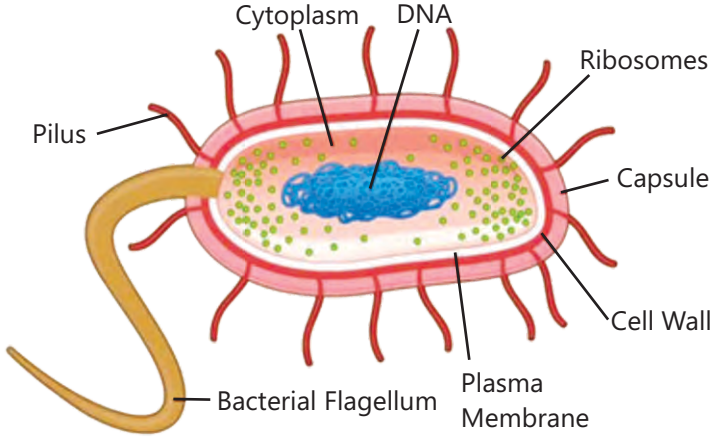


Figure 3.11 Bacterial cell

One or more flagella help the cell to move. Pili can help certain bacteria attach with host cell.

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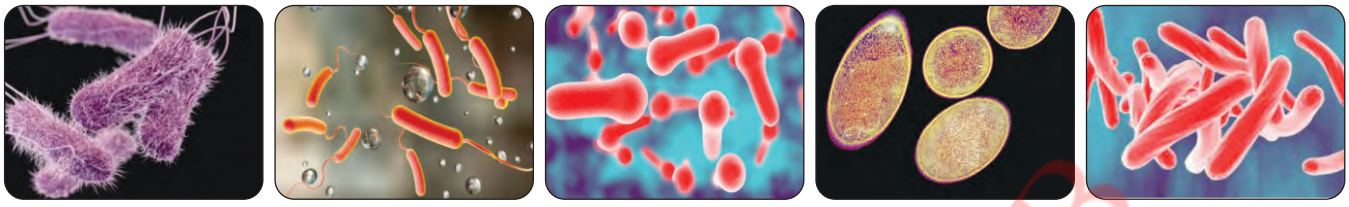
Cholera, diarrhea, typhoid, tuberculosis, tetanus, etc., are the diseases caused by bacteria **(Figure 3.12)**.



Typhoid causing bacteria | Cholera causing bacteria | Tetanus causing bacteria | Diarrhea causing bacteria | Tuberculosis causing bacteria

Figure 3.12 Bacteria causing diseases

3.3.3 Fungi

Fungi are simple organisms that can be single celled or multicellular. They cannot make their own food as fungal cells don't have chlorophyll. They often grow on dead bodies or decaying matter. A typical fungal cell contains a true nucleus, mitochondria, endoplasmic reticulum and golgi apparatus. They have thick walls. The organism's body consists of filaments called **hyphae**. Fungi reproduce by means of spores. Yeast, mould, mushroom, etc. are examples of fungi **(Figure 3.13)**.

Yeast | Mould | Mushroom

Figure 3.13 Common fungi

Athletes foot, jock itch, ringworm, etc., are the diseases caused by fungi **(Figure 3.14)**.

Athletes foot | Jock itch | Ringworm

Figure 3.14 Diseases caused by fungi

3.3.4 Parasites

The organisms that live in or on the body of other organisms are called **parasites**. The organisms on which parasites live are called **hosts**. Parasites obtain food from the hosts. The two main types of parasites which cause diseases in humans are **endoparasites** and **ectoparasites**. The parasites that live inside the body of host (most commonly in blood stream) are called endoparasites. e.g.,

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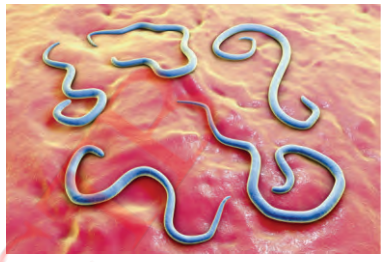
malarial parasite, tape worm, round worm, etc. are the examples of endoparasites **(Figure 3.15)**. The parasites that live outside the bodies of the hosts are called ectoparasites. Insects, such as ticks, lice and mosquitoes, etc., are examples of ectoparasites **(Figure 3.16)**. Worms are larger, multicellular organisms that can live inside as well as outside the human body.

Malarial parasite

Tapeworm



Roundworms

Figure 3.15 Endoparasites

Tick

Lice

Mosquito

Figure 3.16 Ectoparasites

3.4 PARTS OF IMMUNE SYSTEM

The system of body parts (cells, tissues, organs) that work together to defend the body against the attacks of pathogens is called **immune system (Figure 3.17)**.

The organs involved in immune system are found throughout the body and work to produce '**lymphocytes**' and are thus known as **lymphoid organs**. Lymph nodes, thymus, spleen, bone marrow, tonsils, adenoids, appendix and peyer's patches, etc., are the organs called **lymphoid organs**.

Lymph nodes

Lymph nodes are small glands that contain immune cells and found in different parts of the body. When foreign invader enters the body, lymph nodes are activated. They replicate themselves, analyze the foreign body, produce specific lymphocytes and send them to fight off the invader (pathogen).

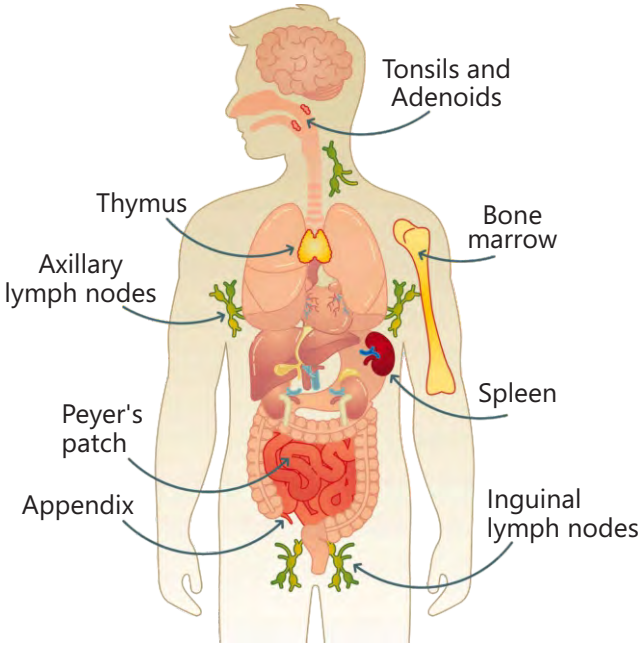


Figure 3.17 Parts of human immune system

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Thymus

Thymus is found in the upper part of the chest, beneath the breast bone. It facilitates maturation of **'T lymphocytes'** which provide cell mediated immunity. The specific task of thymus is to learn, recognize or remember the invader and initiate for the production or selection of T lymphocytes so that their attack can be quickly mounted the next time this invader is encountered.

Spleen

Spleen is purple coloured organ, found in the upper region of left abdomen and protected by rib cage. It stores white blood cells that defend human body against foreign invaders. It filters the blood to destroy old and damaged red blood cells.

Bone marrow

Bone marrow inside the bones produces billions of new blood cells every day and releases them into the blood stream. Bone marrow has stem cells which differentiate into specific cell types, red blood cells, white blood cells, platelets and many other types of immune cells. It strengthens the immune system in our body.

Tonsils

Tonsils are a pair of soft tissues present inside the throat that fight against the infections. They swell up in response to infection.

Adenoids

Adenoids are a patch of soft tissues located behind the nasal cavity. Like tonsils, they help to keep the body healthy. They trap harmful bacteria or viruses we breathe in or swallow. They are important infection fighters in babies and young children.

Appendix

Appendix is a pouch like organ between the small intestine and large intestine. It helps in the maturation of B lymphocytes and takes part in the production of some antibodies.

Peyer's patches

Peyer's patches are the lymphoid tissues present in small intestine. They form an important part of immune system for preventing the growth of pathogenic bacteria in the intestines.

3.4.1 Adaptive Immunity Developed Over Time

Adaptive immunity is not present at birth. It develops when a person's immune system finds and recognizes some foreign invader. Development of adaptive immunity takes days or even weeks. Adaptive immunity is more specific to the pathogens and has memory. It develops after the exposure to an antigen either from a pathogen or some vaccine.

3.5 AVOIDING INFECTIONS

Understanding the ways microorganisms enter our bodies can help to prevent infection. The best way to avoid infection is to keep our bodies and environment clean. Following are some ways that help to prevent infection:

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1. Dirty hands are major source of germs. The germs enter into our body, when we touch our eyes, nose and mouth with dirty hands. Wash your hands before you eat, after you use washroom/toilet, and whenever you touch something used by a sick person **(Figure 3.18)**.
2. Take a bath at least once a day.
3. We can protect ourselves from food infections by eating healthy and fresh food that is free of germs. Wash fruit and vegetables before eating. Avoid eating items that are not properly covered from dust.
4. Keep our home, school and surrounding clean.
5. Clean cuts and bruises in the skin right away with soap and clean water. Covering the wound with bandage also helps to keep infection away.
6. Learn principles of good health and act accordingly.

Figure 3.18 Washing hands with soap washes off the germs

KEY POINTS

- The ability of human body to defend itself against disease causing agents (pathogens) is called immunity.
- The response of human body to a foreign particle (pathogen) in the form of producing antibodies against a specific antigen is called immune response.
- The innate immunity in inherited from parents and protects the individual since birth. It is always present in the body and generates a rapid response.
- The immunity acquired by an individual after the birth is called adaptive immunity. It is developed in response to external factors.
- Active immunity is a type of adaptive (acquired) immunity by which a body produces its own antibodies in response to the pathogens entered in the body.
- Passive immunity is a type of adaptive (acquired) immunity by which readymade antibodies are transferred to the individual.
- Viruses, bacteria, fungi and other parasites are the pathogens causing infectious diseases.
- Hepatitis, typhoid, COVID-19, etc., are the examples of infectious diseases.

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QUESTIONS

3.1 Encircle the correct option.

1. A pigment in the skin that protects harmful effects of sunlight:

a. melanin b. haemoglobin c. lymphocyte d. lysozyme

2. Hydrochloric acid is found in:

a. salavia b. gastric juice c. bile d. pancreatic juice

3. ..... is the inflammation of liver.

a. tuberculosis b. typhoid c. COVID-19 d. hepatitis

4. Billions of new blood cells are produced daily in:

a. heart b. lever c. spleen d. bone-marrow

5. Nuclear membrane is not found in:

a. plant cell b. animal cell c. bacterial cell d. fungal cell

3.2 Give short answers.

1. Define the following:
   (a) Pathogen
   (b) Antigen
   (c) Infection
   (d) Phagocytosis

3.3 Answer the following questions

1. Describe the physical barriers against the pathogens in human body.
2. Explain the non-specific defence against pathogens in human body.
3. Give brief introduction of pathogens (virus, bacteria, fungi). Explain how can they enter human body?
4. What are infectious diseases? Give examples.
5. Describe the parts of immune system.
6. How can we avoid infections?

3.4 Constructed Response Questions

1. What do you think are the modes of transmission of diseases?
2. What do mean by personal hygiene? Describe some basic principles in this regard.
3. Illustrate and give brief introduction of lymphoid organs.

3.5 Investigate how can we strengthen our immune system?

3.6 Make placards to create awareness against infectious diseases.

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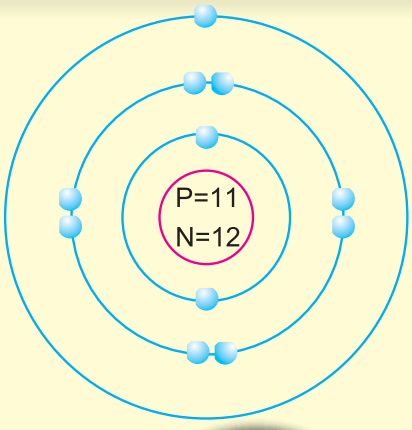

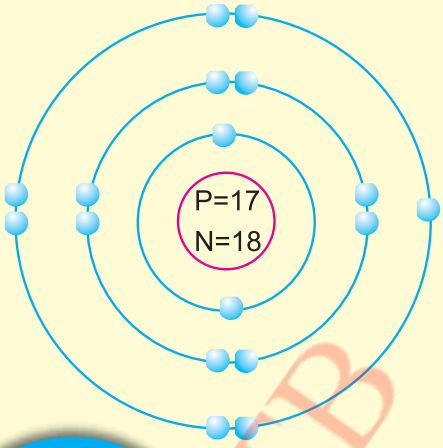

What do you think about the structure of an atom?

What is Periodic Table?

What is electronic configuration?

04 Structure of an Atom

Students' Learning Outcomes

After studying this chapter, students will be able to:

- Describe and draw the structure of an atom in terms of electrons, protons and neutrons.
- Describe how an atom is electrically neutral.
- Differentiate between atomic number and mass number.
- Determine the atomic number and mass number of elements on the basis of the number of protons, electrons and neutrons.
- Show the arrangement of electrons in K, L and M shells of elements.
- Draw the atomic structures of first eighteen elements in the Periodic Table.
- Explain that the Periodic Table is a way to organize elements in a systematic order.
- Recognize periods and groups in the Periodic Table.

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VOCABULARY

Electron	Proton	Neutron	Atomic number	Mass number	Isotopes
A negatively charged particle of an atom found around its nucleus	A positively charged particle of an atom found in its nucleus	A neutral particle of an atom found in its nucleus	Number of protons present in an atom	Total number of protons and neutrons present in an atom	Atoms of the same element having different mass numbers

Recall what you have learnt:

We have learnt as under:

Atom

An atom is the smallest particle of an element that can take part in a chemical reaction. Atoms of a particular element are alike but they are different from the atoms of other elements.

Structure of an atom

The major part of an atom is empty. Its central part is called nucleus. Modern research on atomic structure shows that it consists of a number of smaller particles, the most important of which are **(Figure 4.1)**:

- Proton
- Electron
- Neutron

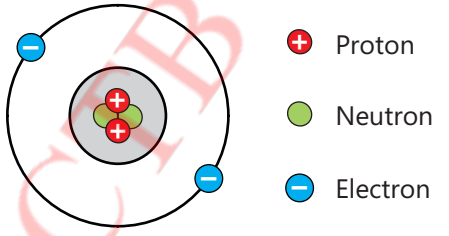

Figure 4.1 **Structure of helium atom**

(i) Proton

Protons are the positively charged particles present in the nucleus of an atom. A proton carries a unit positive charge on it.

(ii) Electron

Electrons are the negatively charged particles revolving around the nucleus of an atom in different orbits. An electron carries a unit negative charge on it.

(iii) Neutron

Neutrons are the neutral particles. They have no charge on them. They are also present in the nucleus of an atom.

Protons, electrons and neutrons are known as the fundamental particles of an atom. The number of protons present in the nucleus of an atom is equal to the number of electrons present around the nucleus. It means that the number of positive charges is equal the number of negative charges present there. The atom is therefore, electrically **neutral particle**.

Symbol

One or two letters from the English or Latin name of an element used to represent its one atom is called **symbol**. Usually the first capital letter of the name of the element is used as symbol. If there are two letters in the symbol, the first is capital and the second is small. For example, H is the symbol of hydrogen and Na is the symbol of sodium taken from its Latin name (Natrium).

Atomic number (Z)

The number of protons present in an atom of an element is called atomic number of that element. It is denoted as **Z**. All the atoms of an element have the same number of protons.

Mass number (A)

The total number of protons plus neutrons present in an atom of an element is called **mass number** of that element. It is denoted as **A**.

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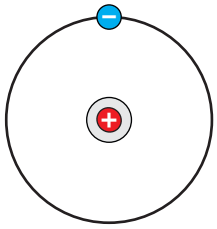
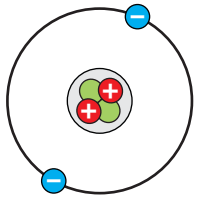
Activity 4.1 Assessment

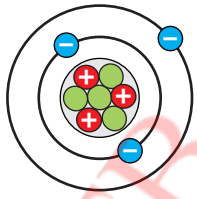
- Examine the structures shown below:



Hydrogen atom



Helium atom



Lithium atom

- Record your observation in the chart given below:

Name of element	Symbol	Atomic Number (Z)	Mass number (A)

Mathematically we can write:

Mass number = Number of protons + Number of neutrons

A = Z + Nnmber of neutrons.

Number of neutrons = A – Z

We can find the number of protons, electrons and neutrons in an atom of an element by knowing its atomic number and mass number. For example atomic number of phosphorus is 15 and its mass number is 31. Since atomic number is the number of protons present in an atom, it means that:

The number of protons in phosphorus atom = 15

We know that, in an atom, the number of protons is equal to the number of electrons.

Hence, the number of electrons in phosphorus atom = 15

Mass number = Number of protons + Number of neutrons

A = Z + Number of neutrons.

Number of neutrons = A – Z

Number of neutrons in phosphorus atom = 31 – 15 = 16

Activity 4.2 Assessment

- Find out and write the number of protons, electrons and neutrons in the atoms of the following elements:

Name of element	Symbol	Atomic Number (Z)	Mass Number (A)	No. of protons	No. of electrons	No. of neutrons
Oxygen	O	8	16			
Magnesium	Mg	12	24			
Phosphorus	P	15	31			
Potassium	K	19	39			

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Informative

- The symbol of an element is used to represent one atom of that element.
- Atomic number given on the symbol of an element in the Periodic Table indicates the number of protons present in one atom of that element.
- The number of electrons present in an atom is equal to the number of protons.

In this chapter we will learn about:

- Atom – An electrically neutral particle
- Energy levels or shells
- Distribution of electrons in K, L and M shells
- Atomic structures of first 18 elements
- Periodic Table

4.1 ATOM – AS A NEUTRAL PARTICLE

We have learnt about charge and that like charges repel each other and opposite charges attract each other. The number of positively charged protons present in an atom is equal to the number of negatively charged electrons present there. It means that the total positive charge on an atom (due to protons) is equal to the total negative charge on it (due to electrons). The equal amounts of positive and negative charges cancel the effect of each other. An atom is therefore electrically neutral particle **(Figure 4.2).**

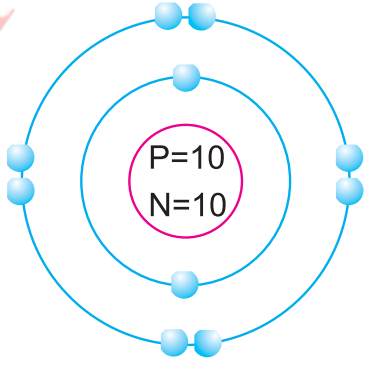

Figure 4.2 Neon atom

4.2 SHELLS OR ORBITS

Areas around the nucleus of an atom where electrons are found are known as shells or orbits. First, second, third and fourth shells are named as K, L, M and N respectively. An integer 'n' is used to describe the position of these shells around the nucleus of an atom. For the first K shell n = 1, for the second L shell n = 2, for the third M shell n = 3 and for the fourth N shell n = 4. The maximum number of electrons which each shell can accommodate can be determined by using the formula $2n^2$ **Table (4.1)**.

Table 4.1 electrons in different shells around an atom

Shell	Value of n	Name of the shell	Maximum of number of electrons = $2n^2$
First	1	K	$2n^2 = 2 \times 1^2 = 2 \times 1 = 2$
Second	2	L	$2n^2 = 2 \times 2^2 = 2 \times 4 = 8$
Third	3	M	$2n^2 = 2 \times 3^2 = 2 \times 9 = 18$
Fourth	4	N	$2n^2 = 2 \times 4^2 = 2 \times 16 = 32$

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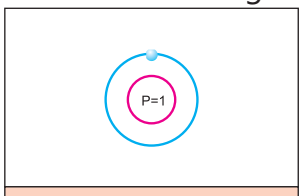
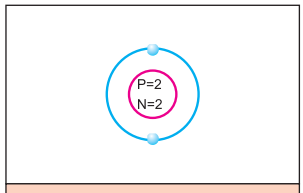
4.3 ATOMIC STRUCTURES OF FIRST 18 ELEMENTS

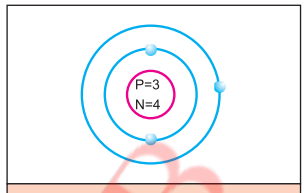
Atomic structures of first eighteen (18) elements of the Periodic Table are shown as follows:



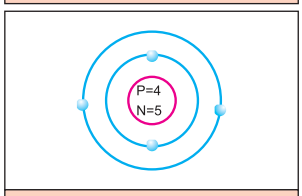
Hydrogen ($^{1}_{1}H$)



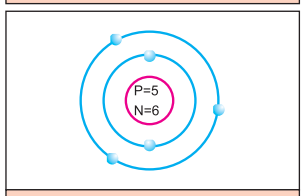
Helium ($^{4}_{2}He$)



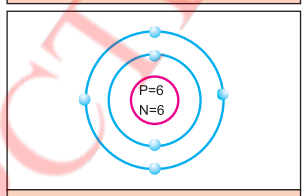
Lithium ($^{7}_{3}Li$)



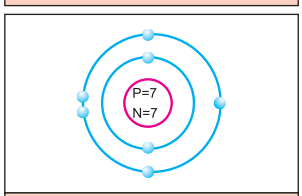
Beryllium ($^{9}_{4}Be$)



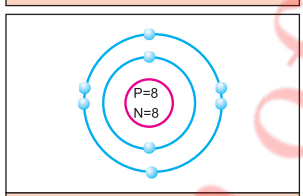
Boron ($^{11}_{5}B$)



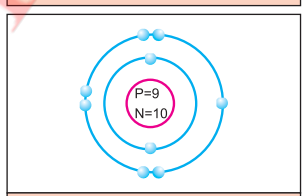
Carbon ($^{12}_{6}C$)



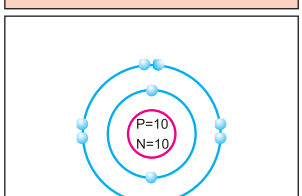
Nitrogen($^{14}_{7}N$)



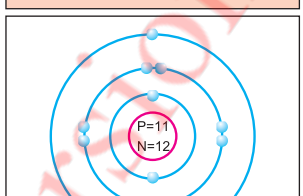
Oxygen($^{16}_{8}O$)



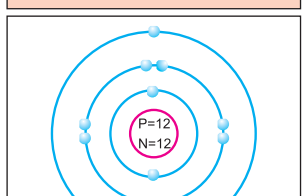
Fluorine($^{19}_{9}F$)



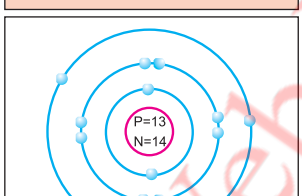
Neon ($^{20}_{10}Ne$)



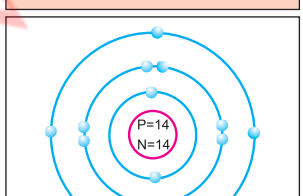
Sodium ($^{23}_{11}Na$)



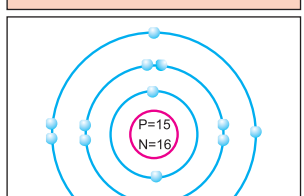
Magnesium ($^{24}_{12}Mg$)



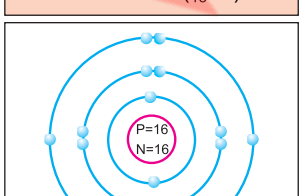
Aluminum ($^{27}_{13}Al$)



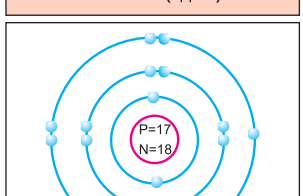
Silicon ($^{28}_{14}Si$)



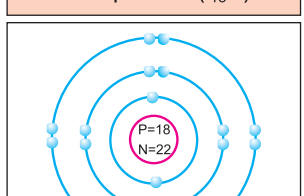
Phosphorus ($^{31}_{15}P$)



Sulphur ($^{32}_{16}S$)



Chlorine ($^{35}_{17}Cl$)



Argon ($^{40}_{18}Ar$)

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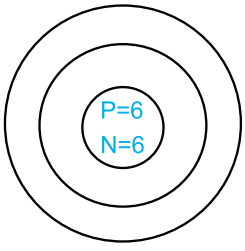
Mini Exercise

- Draw diagrams of atomic structures of the following atoms:

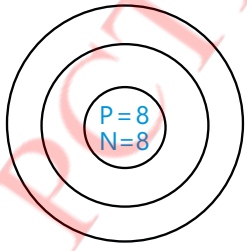
(a)	Magnesium	(Z = 12, A = 24)	(b)	Aluminum	(Z = 13, A= 27)
(c)	Silicon	(Z = 14, A = 28)	(d)	Phosphorus	(Z = 15, A = 31)
(e)	Sulphur	(Z= 16, A = 32)			

Activity4.3

Complete the structures of the given atoms by filling electrons in different shells.



Carbon atom (Z = 6, A=12)



Oxygen atom (Z = 8, A = 16)

4.4 PERIODIC TABLE

Scientists have arranged the elements in a table called the Periodic Table **(Figure 4.3)**. Elements in the Periodic Table are arranged on the basis of their properties and arrangement of electrons around the nuclei in their atoms. Elements kept in columns (groups) have same number of electrons in their outermost shells. They have similar properties. In the rows (periods) from left to right, elements are arranged in an order of increasing atomic numbers.

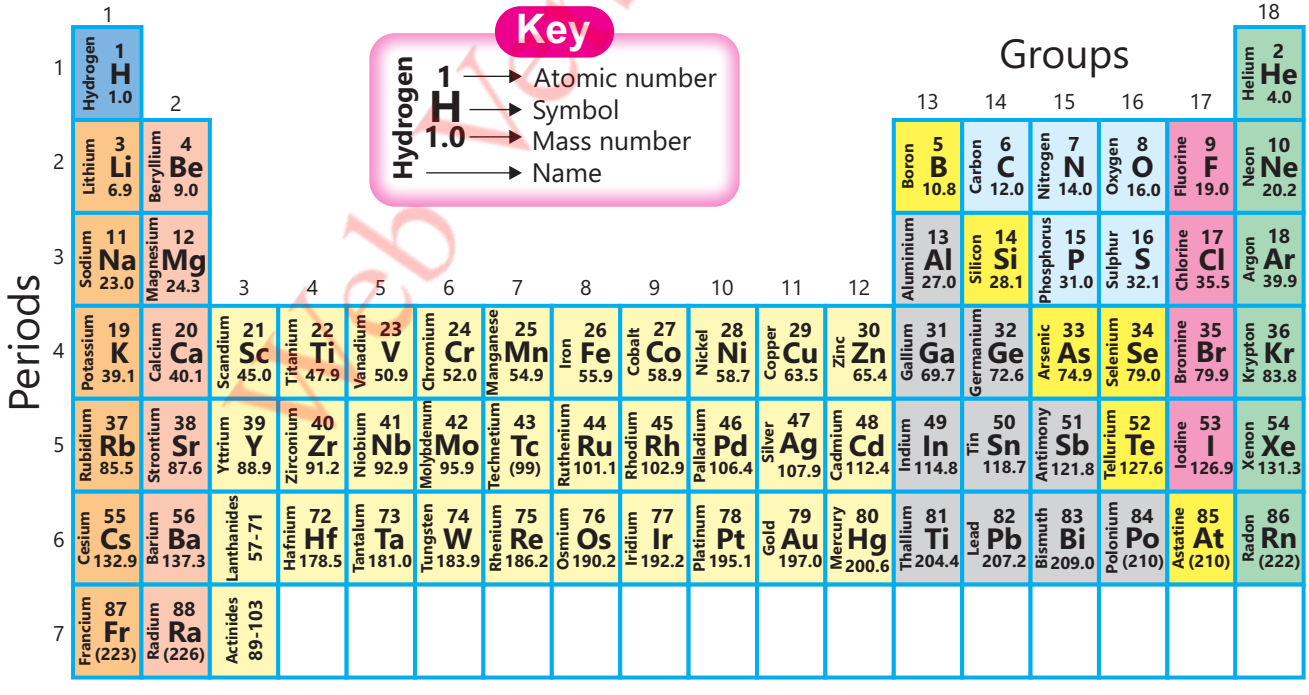


Figure 4.3 The Periodic Table Of Elements

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4.4.1 Periods

Horizontal rows of elements in the Periodic Table are called periods. **Table 4.2** given below shows the number of elements kept in different periods of the Periodic Table based on an order of their increasing atomic numbers.

Table 4.2 Different Periods of the Periodic Table

Period No.	Name of the Period	Number of Elements	Range of Atomic Numbers
1st	Short Period	2	1 to 2
2nd	Normal Period	8	3 to 10
3rd	Normal Period	8	11 to 18
4th	Long Period	18	19 to 36
5th	Long Period	18	37 to 54
6th	Very Long Period	32	55 to 86
7th	Very Long Period	32	87 to 118*

4.4.2 Groups

Columns of the Periodic Table are called **groups**. There are eighteen groups in the Periodic Table. Groups are numbered on the basis of number of electrons in the outermost shells or valence shells of their atoms. For example, each element of group 1 contains one electron in the outermost shell or valence shell of its atoms. Each element of group 2 contains two electrons in the outermost shell or valence shell of its atoms.

Groups 1 and 2 and 13 to 17 contain normal elements. Groups 3 to 12 contain transition elements. The elements of group 18 are called noble gases. **Table 4.3** below shows distribution of different families of elements in groups 1 to 18.

Table 4.3 Different Groups of the Periodic Table

Group No.	Number electrons in valence shell	Family name of elements
1	1	Alkali metals
2	2	Alkaline earth metals
3 to 12		Transition metals

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13	3	Boron family
14	4	Carbon family
15	5	Nitrogen family
16	6	Oxygen family
17	7	Halogen family
18	8	Noble gases

Do you know?

- Carbon, hydrogen, oxygen, nitrogen, phosphorus and calcium are the six elements which contribute about 99 % of our body mass.

KEY POINTS

- An atom is the smallest particle of an element that can take part in a chemical reaction.
- Electrons, protons and neutrons are the fundamental particles of an atom.
- Protons and neutrons are located in the central part of an atom called nucleus, whereas, electrons are found around the nucleus in different shells.
- The number of protons present in the nucleus of an atom is equal to the number of electrons found around the nucleus in different shells.
- The number of protons present in the nucleus of an atom of an element is called atomic number of that element.
- Total number of protons and neutrons present in the nucleus of the atom of an element is called mass number of that element.
- The areas around the nucleus of an atom where electrons are found are known as shells.
- First, second, third and fourth shells are named as K, L, M and N shells.
- An integer 'n' is used to describe the position of a shell around the nucleus of an atom.
- The maximum number of electrons which a shell can accommodate can be determined by the formula $2n^2$.
- Scientists have arranged the elements in a table called the Periodic Table.
- Elements in the Periodic Table are arranged on the basis of their properties and arrangement of electrons around the nuclei of their atoms.

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QUESTIONS

4.1 Encircle the correct option.

1. An element with fifteen protons in its atomic nucleus has atomic number:

a. 5 b. 10 c. 15 d. 20

2. The central part of an atom is called:

a. electron b. proton c. neutron . nucleus

3. Letter K is used to express the -------- shell around the nucleus of an atom.

a. 1^{st} b. 2^{nd} c. 3^{rd} d. 4^{th}

4. The total number of electrons which M shell can accommodate:

a. 2 b. 8 c. 18 d. 32

5. The particle of an atom having negative charge on it:

a. electron b. proton c. neutron d. nucleus

6. Atomic number of element present in period 2 and group 15 of the Periodic Table:

a. 4 b. 5 c. 6 d. 7

7. How many periods are there in the Periodic Table?

a. five b. six c. seven d. eight

8. Formula showing maximum number of electrons in a shell:

a. n^2 b. $2n^2$ c. $3n^2$ d. $4n^2$

9. The mass of an atom is almost due to the:

a. electrons b. protons c. neutrons d. nucleus

10. The particles of an element having different mass numbers:

a. protons b. neutrons c. atoms d. isotopes

4.2 Write short answers.

1. What is atom?
2. Define element.
3. What type of charge is present on neutron?
4. What do you mean by atomic number?
5. What is mass number?

4.3 Constructed Response Questions

1. Oxygen is a non-metallic element.
   (a) What is atomic number of oxygen?

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(b) In which group of the Periodic Table, oxygen is located?

(c) In which period of the Periodic Table, oxygen is located?

(d) How many electrons are required by oxygen atom to complete its valence shell

2. Sodium is a metallic element.

(a) What is symbol of sodium?

(b) What is atomic number of sodium?

(c) What is the period number of sodium in Periodic Table?

(d) What is the group number of sodium in Periodic Table?

(e) Name the family of metals, sodium belongs to.

3. Name the members of the following families in the Periodic Table:

(a) Alkali metals

(b) Alkaline earth metals

(c) Halogens

(d) Nobel gases

4. Name the element having the same period number and group number.

5. What does $^{27}_{13}Al$ indicate?

6. Why do H and Be exist as atoms while He and Ne as molecules?

7. What does electronic configuration mean?

8. What is the difference between an atom and isotope?

4.4 Investigate the isotopes and their uses.

4.5 Project

1. Draw the atomic structures of sodium and magnesium having atomic number 11 and 12 respectively.

2. Draw the atomic structures of chlorine and argon having atomic number 17 and 18.

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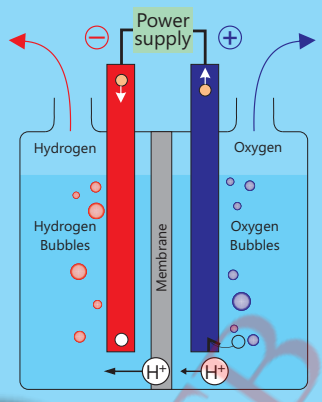

What is water chemically?

What happens to water when electric current is passed through it?

Why do we paint the objects made of iron?

05 Physical and Chemical Changes

Students' Learning Outcomes

After studying this chapter, students will be able to:

- Differentiate between physical and chemical changes while considering daily life examples.
- Recognize that oxygen is needed in combustion, rusting and tarnishing.
- Explore methods of preventing rusting.
- Relate uses of materials to their chemical properties (e.g., tendency to rust, flammability).
- Evaluate Impact of combustion reaction on environment.
- Relate uses of materials to their physical properties (e.g., melting point, boiling point, solubility, thermal conductivity).
- Distinguish between physical and chemical properties of matter.

VOCABULARY

Chemical reaction	Reactant	Product	Tarnish	Chemical equation	Flammability
A change in the chemical structure and composition of a substance	A substance which takes part in a chemical reaction	A substance which is formed during a chemical reaction	A thin film of corrosion metallic formed over the objects of copper, brass, magnesium, etc.	Representation of a chemical reaction in terms of symbols, formulae and signs	Ability of a substance to catch fire.

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Recall what you have learnt

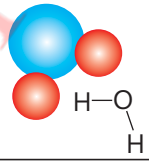
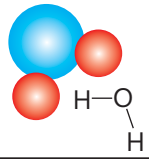
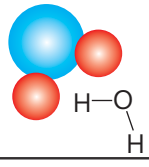
Physical and chemical changes are associated with the structures of substances.

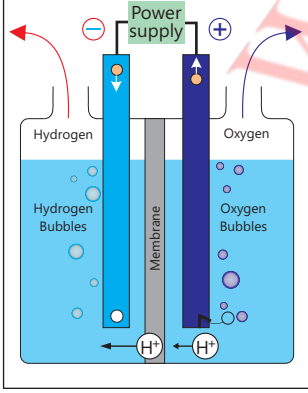
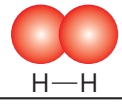
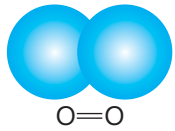
A change during which the structure of a substance does not change is called physical change.

A change during which the structure of a substance is changed is called chemical change

Activity and inquiry based learning

Activity 5.1

Take water in a pan	Inquiry	Reply
	What is the structure of water?	
	What happens to water on heating it strongly?	It changes into its gaseous state (steam)
	What is the structure of steam?	
	Whether the change of water into steam is a physical or a chemical change.	Physical change.
	What happens to water on cooling it?	It changes into its ice (its solid state)
	What is the structure of ice?	
	Whether the change of water into ice is a physical or a chemical change.	Physical change.

Request your teacher pass electric current through water	Inquiry	Reply
	What happens to water when electric current is passed through it?	Water changes into its constituents, i.e., hydrogen (H_2) and oxygen (O_2) elements.
	What is the structure of hydrogen gas?	
	What is the structure of oxygen gas?	
	Whether the change of water into hydrogen and oxygen is a physical or a chemical change.	Chemical change.

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5.1 PHYSICAL AND CHEMICAL CHANGES

The changes, which take place in the substances, fall into two groups.

- Physical changes
- Chemical changes

5.1.1 Physical Changes

A change in the physical properties of a substance is called physical change. Physical change is a temporary change. The form of a substance appears as the result of a physical change can be reversed into its original form by a simple physical method. For example, water on freezing changes into ice, which can be reversed to liquid water on heating. Water on heating changes into steam, which can be reversed to liquid water on cooling. **(Figure 5.1)**

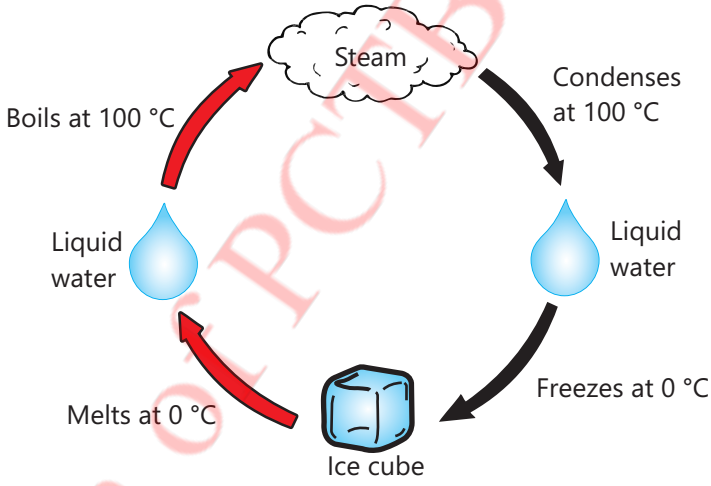


Figure. 5.1 Conversion of one state of water to another.

During physical changes substances do not lose their chemical structure and chemical properties.

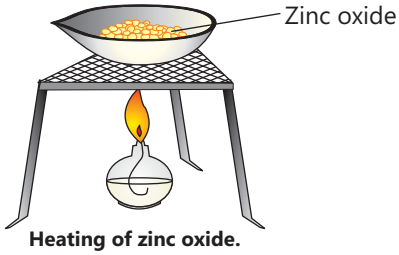
Other examples of physical changes are given below.

Heating of zinc oxide

Zinc oxide is a white solid substance. Its colour changes from white to yellow on heating. And then on cooling, it changes back to original white colour. This change of colour is a physical change.

Activity 5.2

Take a small quantity of zinc oxide (a white solid) in a china dish. Heat it and observe the change in colour from white to yellow. Stop heating and observe the reverse of the physical change on cooling.



Heating of zinc oxide.

Brain teaser

Physical changes don't make new substances. When sugar is dissolved in water, a sweet solution formed is different from pure water. Is this a physical change?

Heating of nichrome wire

Nichrome wire is silver-grey in colour. On heating, it first becomes red-hot and then white-hot. On cooling, its original silver-grey colour is returned.

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Dissolving common salt in water

When some common salt is mixed in water, it dissolves. It is a physical change because the salt remains the same chemically in the solution and can be separated by boiling the solution. On boiling, water evaporates and white residue of common salt is left behind. **(Figure 5.2)**

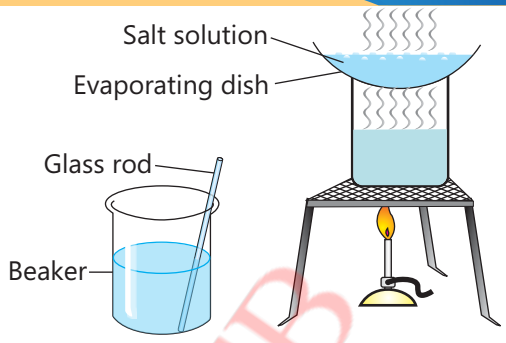


Figure 5.2 **Dissolving common salt in water and boiling the solution**

5.1.2 Chemical Changes or Chemical Reactions

A change in chemical properties of a substance is called chemical change. As chemical properties are associated with the chemical structure of a substance, hence a change in chemical structure of a substance or substances, which results into new kinds of substances with different properties is called a chemical change or chemical reaction.

During chemical changes, entirely new substances with different physical and chemical properties are formed. These new substances cannot be reversed into their original forms by simple physical methods. Rusting of iron, burning of fuel and digestion of food, etc., are the examples of chemical changes or chemical reactions.

The things, which take part in a chemical reaction, are called **reactants**. The new substances, which are produced in a chemical reaction, are called **products** of the reaction.

5.1.3 Role of Oxygen in Natural Chemical Reactions

Combustion

When we rub a matchstick on the side of the matchbox, it begins to burn. The process of burning is called **combustion**. Combustion is a chemical change which appears when oxygen of the air reacts with the fuel like coal, etc.

$$C + O_2 \longrightarrow CO_2 + \text{Heat}$$

Scientific Investigation

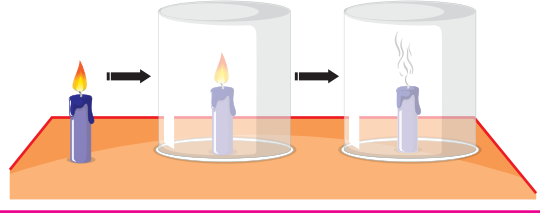
Teacher Guide

Facilitate the students to conduct the activity and investigation as under:

1. What is cholesterol, its sources and effects on human health?
2. How does physical exercise keep you fit and healthy?

Activity 5.3

- Light a candle with the help of a matchstick.
- Cover the burning candle by a beaker as shown in the Figure, so that air cannot enter inside the beaker.
- Observe what happens to the burning candle.



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Hypothesis

"Oxygen is needed in combustion."

Investigation and discussion

- Conduct an interactive discussion on what you observe during the activity 5.9.
- Encircle the correct option from those given against the following inquiry:

Inquiry 5.1

- The burning candle extinguishes because:
  - a. carbon dioxide of the air is cut off.
  - b. oxygen of the air is cut off.
  - c. nitrogen of the air is cut off.
  - d. water in the air is cut off.
- What do you conclude?

Conclusion

Rusting

It is our general observation that things made of iron get rusted if placed in open air for a few days. Rusting is a chemical change during which oxygen in the moist air reacts with the iron (Fe) to convert it into iron oxide (rust):

$$Fe + O_2 \text{ (moist air)} \longrightarrow Fe_2O_3$$

Figure 5.3 Rusting of iron

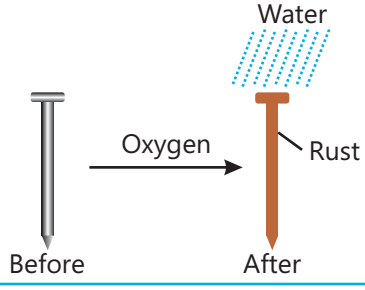
Scientific Investigation

Teacher Guide

Facilitate the students to conduct the activity and investigation as under:

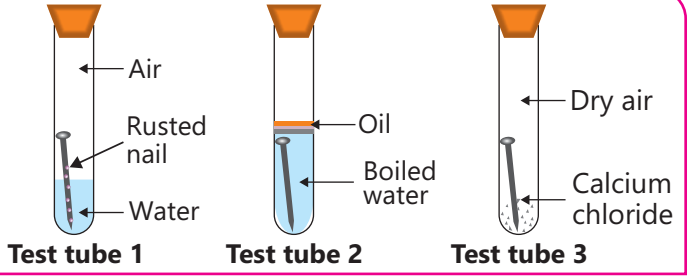
Activity 5.4

- Take an iron nail and clean it by rubbing with sand paper.
- Place it in moist air for 4 to 5 days
- Observe what happens to the nail.



Activity 5.5

- Take three small iron nails and clean them by rubbing with sand paper.
- Place one nail dipped half in water, the second nail completely dipped in boiled water covered with a layer of oil and the third nail in dry air over solid calcium chloride for 4 to 5 days.
- Observe what happens to the three nails.



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Hypothesis

"Oxygen is needed in rusting."

Investigation and discussion

- Conduct an interactive discussion on what you observe during the activity 5.4.

Inquiry 5.2

- Which of the following is agreed upon during the discussion with the teacher?
  a. Nail in test tube 1 rusted because both moisture and oxygen were provided.
  b. Nail in test tube 2 could not rust because oxygen was not provided.
  c. Nail in test tube 3 could not rust because moisture was not provided.
  d. Rusting needs dry air.
- What do you conclude?

Conclusion

Tarnishing

Chemical reaction of oxygen with other substances is called **oxidation**. We have learnt combustion and rusting as examples of oxidation. Tarnishing is also an example of oxidation. Tarnish is a thin film of corrosion that forms on the surface of the objects made of silver, copper, brass, aluminium, magnesium, etc. The thin layer formed on the objects by tarnishing is dull, blackish or grayish in colour. Tarnishing happens when atmospheric oxygen reacts with these substances **(Figure 5.4)**. It also occurs when non-metals other than oxygen, e.g., sulphur react with the outer surface of metals objects. Unlike corrosion or rust, tarnish is a surface phenomenon.

Brain teaser

Metals are used to make alloys which are rust resistant. Is this a chemical change?

Figure 5.4 Tarnished coins

Tarnish can also be caused by the reaction with hydrogen sulphide or sulphur dioxide. Silver needs hydrogen sulphide to tarnish. It can tarnish with oxygen over time.

Silver + Hydrogen sulphide + Oxygen ⟶ Silver sulphide + Water

Heating of sugar

When sugar is heated strongly, it is changed into a black mass of carbon and water. Water evaporates in the form of steam. Water and carbon are chemically quite different substances from the sugar. They cannot be converted back into sugar by physical methods. So this is a chemical change.

$$\underset{\text{Sugar}}{C_{12}H_{22}O_{11}(s)} \xrightarrow{\text{Heat}} \underset{\text{Carbon}}{12C\ (s)} + \underset{\text{Water}}{11H_2O\ (g)}$$

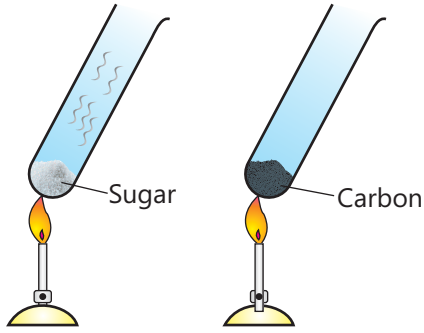

Fig. 5.5 Heating of sugar

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Heating of potassium chlorate

When a small amount of potassium chlorate is heated in a test tube, it first melts into a clear liquid. On further heating, bubbles of a gas escape from it and a white solid potassium chloride is left behind in the test tube. The gas given off is oxygen.

$$\underset{\text{Potassium chlorate}}{2KClO_3\ (s)} \longrightarrow \underset{\text{Potassium chloride}}{2KCl\ (s)} + 3O_2\ (g)$$

Potassium chloride and oxygen are quite different chemically from potassium chlorate.

Burning of magnesium in air

When a piece of magnesium ribbon is heated in air, it burns brightly and a white ash is formed. This white ash is a new substance, magnesium oxide with different composition and properties from those of magnesium and oxygen.

$$\underset{\text{Magnesium}}{Mg\ (s)} \longrightarrow \underset{\text{Oxygen}}{O_2\ (g)} + \underset{\text{Magnesium Oxide}}{2MgO\ (s)}$$

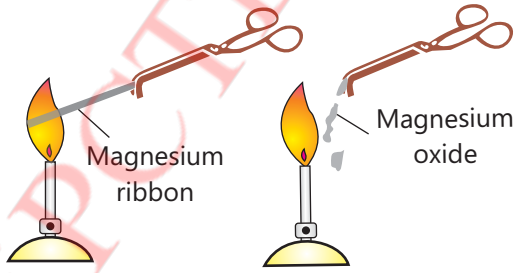

Figure 5.6 Burning of magnesium in air

Comparison between physical and chemical changes

Physical Change	Chemical Change
1. It involves a change in the physical properties of a substance. 2. The chemical composition of the substance does not change. 3. It is easily reversible.	1. It involves a change in the chemical properties of a substance. 2. The chemical composition of the substances change and new substances with different properties are formed. 3. It is not easily reversible.

5.1.4 Impact of Combustion on Environment

Combustion includes burning of fuel. The energy needs in almost all the fields and domestic set up is met by burning of fuel. On the other side, the gaseous emission during burning of fuel is the primary source of environmental pollution. **Table 5.1** given below reveals different kinds of gaseous emissions from combustion and their effects on environment:

Table 5.1 Effects of emissions from combustion on the environment

Products of combustion	Effects on environment
Carbon dioxide, Nitrous oxide, water vapours and methane	Increase greenhouse effect which causes global warming
Carbon monoxide (CO) and particulate (dust, soot, fumes, etc.)	Incomplete combustion produces carbon monoxide which is a poisonous gas. Carbon monoxide and particulate cause smog in the environment.
Sulphur dioxide (SO_2), nitric oxide (NO) and volatile organic compounds (VOCs)	Causing smog and acid rain

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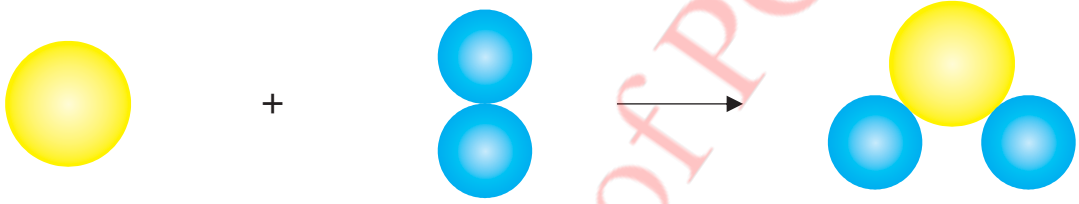
Lead, sulphur, etc., (Trace elements)	Lead and sulphur, etc. are potential carcinogens. Their existence in environment causes fatal diseases like cancer.
Compound of hydrogen with fluorine, chlorine, bromine, iodine, etc.	Potential carcinogens. Also cause global warming.

5.2 CHEMICAL EQUATION

The representation of a chemical reaction in terms of symbols, formulae and signs is called chemical equation. A chemical equation is used to describe a chemical reaction. In a chemical equation, the formulae or symbols of the reactants are written on the left-hand side and the formulae or symbols of the products are written on the right-hand side. The reactants and products are separated by an arrow, which is directed towards the products. For example, the picture given below shows a reaction of sulphur with oxygen to form sulphur dioxide.



Sulphur **Oxygen** **Sulphur dioxide**

The chemical equation for this chemical change or chemical reaction is as follows.

$$S\ (s) + O_2\ (g) \longrightarrow SO_2\ (g)$$

In this chemical change, sulphur and oxygen are called reactants as they take part in the chemical reaction and sulphur dioxide is the product of the reaction. In the chemical equation of this reaction, (s) indicates the solid state of sulphur and (g) indicates the gaseous states of oxygen and sulphur dioxide. Sulphur dioxide is a quite different thing from sulphur and oxygen.

Similarly, when zinc metal reacts with hydrochloric acid, zinc chloride is formed and hydrogen gas is given off. This chemical change can be represented by the chemical equation as below.

$$\underset{\text{Zinc}}{Zn\ (s)} + \underset{\text{Hydrochloric acid}}{2HCl\ (aq)} \longrightarrow \underset{\text{Zinc chloride}}{ZnCl_2\ (aq)} + \underset{\text{Hydrogen}}{H_2\ (g)}$$

In this chemical change, zinc and hydrochloric acid are the reactants as they take part in the reaction. Zinc chloride and hydrogen are the products as they are produced in the result of the chemical reaction. In the chemical equation of this reaction, (s) indicates the solid state, (aq) indicates the aqueous state (dissolved in water) and (g) indicates the gaseous state of the substances. The chemical equation also shows that one mole (gram atom) of zinc reacts with two moles (gram molecule) of hydrochloric acid to form one mole zinc chloride and one mole of hydrogen gas.

5.3 PHYSICAL AND CHEMICAL PROPERTIES

Physical properties are due to the physical behaviour of the substances. For example some substances exist in solid state, some exist in liquid state and some in gaseous state at normal temperature and pressure. Hence state is a physical property. Similarly colour, taste, odour, elasticity, strength, density, hardness, melting point, boiling point, solubility and conductance etc. are the physical properties of matter. We would discuss here a few of them.

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(i) Hardness

The hardness of a material is its ability to withstand scratches and wear. A substance can scratch all other substances that are softer than it, but cannot scratch those that are harder. Diamond and graphite are the two forms of carbon. Diamond is extremely hard and can only be cut by other diamond. Graphite is soft.

Figure 5.7 (a) The iron nail scratches the plastics
(b) Two forms of carbon, diamond and graphite

(il) Solubility

The solubility of a substance in a solvent (usually liquid) is the maximum amount of that substance which can be dissolved in 100 gram of the solvent at a particular temperature and pressure. Water is the most common solvent because a large number of substances can dissolve in it. The substances that do not dissolve in water may be soluble in other solvents.

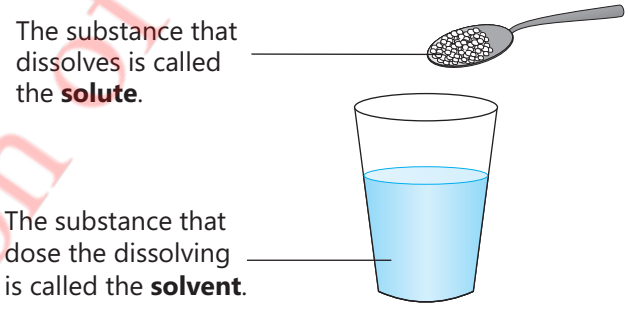

Fig. 5.8 The solute and the solvent together make up a solution.

Activity 5.6

Take 500 cm water in a beaker. Add 10 g sugar in it, shake well and observe.

	Questions	Answers
1	What happens to the sugar?	It dissolves in water.
2	What is this property of sugar called?	Solubility.
3	Is the solubility a physical property?	Yes, solubility is a physical property of matter.

(i) Melting point

Melting point is the specific temperature for a solid at which, it begins to melt. A temperature at which, solid state of a substance is in equilibrium with its liquid state at standard pressure is called melting point of that substance. For example, the melting point of water is 0 °C.

Fig. 5.9 Candle wax melts when heated

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(i) Boiling point

Boiling point is the specific temperature for a liquid at which, it begins to boil and converts from liquid state to gaseous state. The temperature at which, the vapor pressure of a liquid becomes equal to the atmospheric pressure is called boiling point of that liquid. For example the boiling point of water is 100 °C.

Figure 5.10 Water boils at 100 °C to become steam

5.3.1 Chemical Properties

Chemical properties are associated with the chemical structure of the substance. A change in the chemical properties of a substance is called chemical change or chemical reaction.

5.4 USING CHEMICAL PROPERTIES OF MATERIALS

Reactivity, flammability, acidity, etc., are the chemical properties of the materials due to which they are used in preparing useful products.

Reactivity

Reactivity is the tendency of substance to under go chemical reactions. Decomposition of baking powder on heating produces carbon dioxide. Due to this property, baking powder is used in the materials of bakery products (bread, etc.). Carbon dioxide produced from baking powder on heating makes the products (bread, etc.) porous, soft and fluffy.

Chlorine is used in detergents and stain removers due to its bleaching nature in the presence of moisture. This property of chlorine and other substances in the detergents is used for cleaning laundry and other washing purposes.

Acidity

Acidity in stomach produced due to hydrochloric acid in gastric juice is used in digestion of food. Acidity produced by acidity regulators helps to preserve the original taste and colour of food products. It also prevents the growth of dangerous microorganisms in preserved food products.

Flammability

Flammability is the ability of substances to burn. Burning of acetylene with oxygen produces a high temperature flame used for welding and cutting of metals **(Figure 5.11)**.

Figure 5.11 Acetylene flame

5.5 USING PHYSICAL PROPERTIES OF MATERIALS

Conductivity, solubility, freezing point, boiling point, etc., are the physical properties of the materials due to which they are used for various purposes in life.

Conductivity

Conductivity is a physical property of metals to conduct electric current through them. Metallic wire, e.g., copper wire is spread in electric wirings in our homes, schools, industries and where the electricity is required. In this way, the conductivity of copper is used for making use of electricity in almost every walk of life.

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Solubility

Water is an excellent solvent. Due to this property, water dissolves digested food and facilitates its passage into blood through walls of the intestines. Most of the medicines are dissolved in water to be injected into blood. Nutrients in soil are dissolved in water for their diffusion into roots.

Freezing point

Milk, milk products and other food items are freezed at their freezing points to increase their shelf life. A variety of medicines is kept at freezing points to store them for long time.

Boiling point

During fractional distillation of crude oil, different components (natural gas, petrol, diesel, etc.) are separated at their boiling points.

Do you know?

When rocks become extremely hot, they transform into a liquid called magma or lava.

5.6 PREVENTION OF RUSTING

The objects made of iron are damaged if they are not kept safe from rusting. We can take the following measures to prevent metallic objects from rusting:

Applying oil

Coating a layer of oil on the objects keeps the air and moisture away from them. In this way, the objects remain safe from rusting.

Applying paints

Applying paint on the surface of the objects keeps the air and moisture away from them. In this way, the objects remain safe from rusting.

Forming alloy

Making alloys of iron is a better method to avoid rusting. Stainless steel is an alloy of iron that can be used in many cases.

Dry coating

Applying rust-preventing dry coating is useful in shipping, storage, etc. These coatings dry quickly forming a protective layer on metal parts and equipment.

Proper storage

Proper storage of metal parts and equipment in a dry or low moist area where temperature conditions are not suited to rusting is also a better strategy to avoid rusting.

Galvanizing

Application of protective zinc coating over iron or steel products is called galvanizing. It is an excellent rust barrier.

Coat powder

A solid powder of acrylic, vinyl, epoxy, etc., is used to keep the moisture away from the metal object. In this way rusting can be avoided.

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KEY POINTS

- The substances possess certain characteristics, which distinguish them from each other. These characteristics of the substances are called their properties.
- Physical state, colour, odour, taste, melting point, boiling point, solubility and conductance etc. are examples of the physical properties.
- Burning of fuel, digestion of food and rusting of iron etc. are the examples of chemical properties.
- A change in physical properties of a substance is called physical change.
- A change in chemical properties of a substance is known as chemical change or chemical reaction.
- The representation of a chemical reaction in terms of symbols, formulae and signs is called chemical equation. A chemical equation is used to describe a chemical reaction.
- A chemical change in the chemical structure and composition of a substance is called chemical reaction.
- A substance that takes part in a chemical reaction is called reactant.
- A substance which is formed during a chemical reaction is called product.
- The representation of chemical reaction in terms of symbols, formulae and signs is called chemical equation.
- A chemical reaction of oxygen with some other substance is called oxidation. Combustion, rusting and tarnishing are the examples of oxidation.
- Both the oxygen and moisture are needed for rusting.
- Oil, paints, dry coating, alloy formation, galvanizing, proper storage, etc,, are the measures to avoid rusting of metals.

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QUESTIONS

5.1 Select one or more answers as indicated?

(i) Three of the following are alike. Select the one that is different from the others.

a. Solubility
b. Conductance
c. Oxidation
d. Boiling of a substance

(ii) A physical change occurs when:

a. Iron rusts.
b. Solution of common salt is heated
c. A piece of wood burns.
d. Sugar is heated strongly.

(iii) A gas produced on heating solid potassium chlorate is:

a. Hydrogen
b. Carbon dioxide
c. Methane
d. Oxygen

(iv) Select all that happen during a chemical change.

a. A temporary change occurs.
b. Composition of the substances is changed.
c. Properties of the substances are changed.
d. New substances with different properties are formed.

(v) Freezing of a liquid is a:

a. chemical change.
b. chemical property.
c. physical change.
d. None of above.

(vi) What are the products when electric current is passed through water?

a. only steam
b. hydrogen and steam
c. hydrogen and oxygen
d. oxygen and steam

(vii) A piece of iron is kept in open air for 5 days. A film of corrosion formed over it is:

a. iron oxide
b. iron sulphide
c. iron chloride
d. iron hydride

(viii) During combustion, a substance reacts with:

a. hydrogen
b. water
c. carbon dioxided. oxygen

(xi) The temperature at which a liquid's vapour pressure is equal to the external pressure surrounding the liquid is:

a. melting point
b. boiling point
c. freezing point
d. highest temperature

(x) Silver + Hydrogen sulphide + Oxygen ⟶ Silver sulphide + water
The above reaction is known as:

a. combustion
b. rusting
c. tarnishing
d. dehydration

5.2 Define the following:

1. Physical change
2. Chemical change
3. Physical property
4. Chemical property
5. Melting point
6. Freezing point
7. Boiling point
8. Solubility
9. Rusting
10. Tarnishing

5.3 Complete the following:

(a) Hydrogen + Oxygen ⟶
(b) Carbon + Oxygen ⟶
(c) Methane + Oxygen ⟶
(d) Nitrogen + Hydrogen ⟶
(e) Iron + Sulphur ⟶

5.4 Answer the following questions.

1. What are physical changes? Explain with examples.
2. Describe role of oxygen in various chemical reactions that occur naturally.
3. How can we prevent the objects made of iron from rusting?

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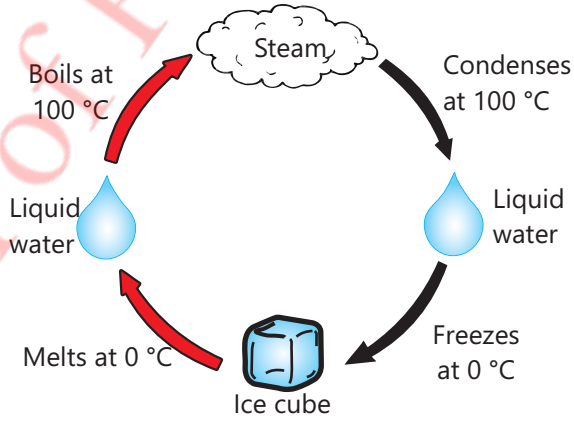
4. Describe the uses of materials with respect to their physical properties.
5. Describe the uses of materials with respect to their chemical properties.

5.5 Constructed Response Questions

1. The gas we use in our kitchen is mostly methane.
   (a) What are the reactants when we burn methane is burnt?
   (b) What are the products when we burn methane is burnt?
   (c) Write the word equation for burning of methane.
2. Wet clothes are hanged in the sun and they become dry.
   (a) What happens to the water in wet clothes?
   (b) What makes its removal from the clothes?
   (c) Is this a chemical change?
   (d) Name the process involved in this change
3. Observe the phenomena given in Figure and answer the following questions.
   (a) Point out the changes being happened.
   (b) Identify the chemical changes occurring therein.
   (c) Identify the physical changes occurring therein.
   (d) Name the processes involved in the whole phenomena.



5.6 Investigate the role of boiling points of different components of crude oil in their separation during fractional distillation of crude oil.

5.7 Project:

Teacher Guide

Facilitate the students to:

(a) conduct a seminar in your school on "the impact of emissions from combustion of fuel on the environment".
(b) invite some experts from Environmental Protection Authority (EPA) for throwing light on the topic.
(c) collect the data from EPA experts regarding pollutants and their effects on the environment.
(d) conduct a research and prepare a research paper on the topic under discussion (impact of emissions from combustion of fuel on the environment) for publication in your school magazine.

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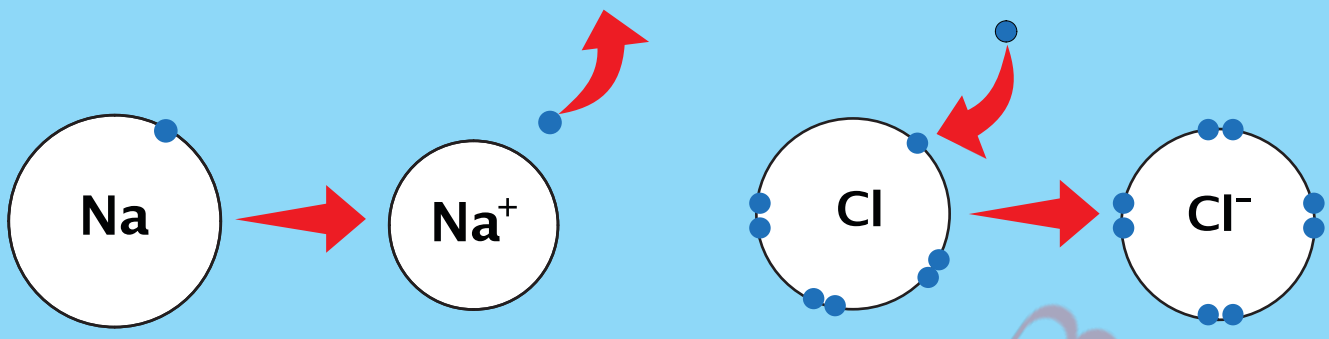

How do atoms of metallic elements exist?

How do atoms of non-metallic elements exist?

How do atoms of noble gases exist?

06 Chemical Bonds

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Students' Learning Outcomes

After studying this chapter, students will be able to:

- Define valency and explain the formation of ions.
- Write chemical formulae on the basis of valency of the constituent elements. such as H_2O, NaCl, NH_3, CO_2, CO, etc.
- Recognize that a chemical bond results from the attraction between atoms in a compound and that the atoms' electrons are involved in this bonding.

VOCABULARY

Electronic configuration
Arrangement of electrons around the nucleus of an atom

Valency
Combining capacity of an atom of the element

Chemical bond
A force that combines the atoms together

Cation
An cation is formed when an atom loses electron(s)

Ionic bond
Chemical bond formed by complete transfer of electron(s) form one atom to another

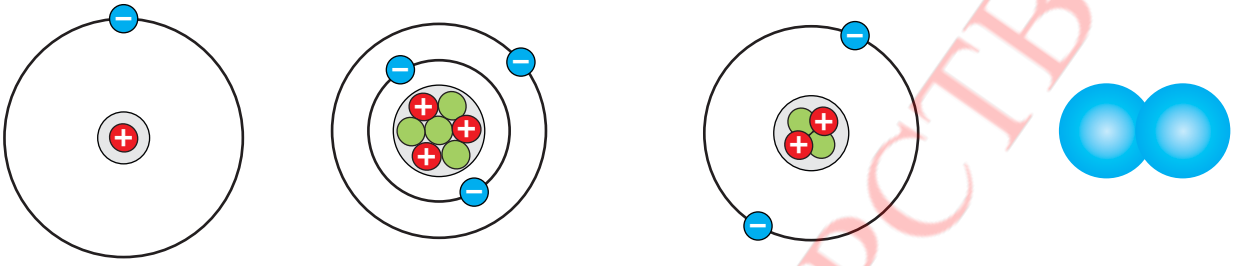
Anion
An anion is formed when an atom gains electron(s)

Covalent bond
Chemical bond formed by mutual sharing of electrons between the atoms

Recall what you have learnt

We have learnt about:

- Atoms, molecules and electronic configuration **(Figure 6.1)**
- Electrons around the nucleus of an atom are arranged in different shells (K, L, M and N)
- Maximum number of electrons each of the first (K), second (L), third (M) and fourth (N) shell can accomodate



(a) Atom (b) Atomic structure of lithium (c) Monoatomic molecule (d) Diatomic molecule

Figure 6.1 Atom, monoatomic molecule and diatomic molecule

Activity 6.1 Assessment

Write **'C'** against the correct and **'I'** against the incorrect statement in the middle column. Also correct the incorrect statement and write it in the next column.

Correct / Incorrect	C / I	Correct
Figure 6.1 (a) given above is of hydrogen atom.		
In Figure 6.1 (b) given above, the outermost shell (orbit) is completely filled with electrons.		
In Figure 6.1 (c) given above, the outermost shell (orbit) is completely filled with electrons.		
The particle shown in Figure 6.1 (d) above cannot exist independently.		

In this chapter we will learn about:

- Ion
- Valency
- Chemical bond

6.1 ION

An atom whose outermost orbit (shell) is completely filled with maximum number of electrons that it can accommodate, does not need any more electron(s). Its electronic configuration is complete or stable. The atom having **stable electronic configuration** can exist independently and the particle that can exist independently is called molecule **(Figure 6.1-c)**.

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An atom whose outermost orbit (shell) is not completely filled with maximum number of electrons that it can accommodate has an incomplete or **unstable electronic configuration**. The atoms with unstable electronic configuration tend to have a completely filled outermost orbit (attain stable electronic configuration). They can do so either by gaining electron(s) or by losing electron(s). When an atom loses electron(s), it becomes positively charged **(Figure 6.2)**. This is because the number of electrons decreases there than the number of protons in the atom.

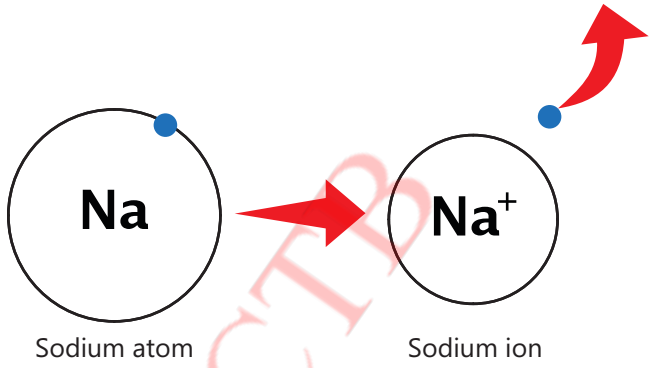

Figure 6.2 Sodium atom loses electron and attains a positive charge on it

When an atom gains electron(s) from some other atom, it becomes negatively charged **(Figure 6.3)**. This is because the number of electrons increases there than the number of protons in the atom.

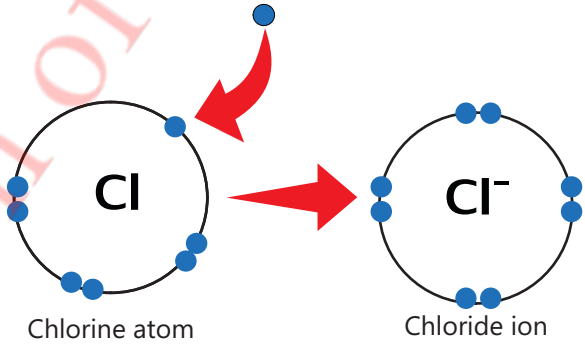

Figure 6.3 Chlorine atom gains electron and attains a negative charge on it

The charged particle (atom or group of atoms) is called **ion**.

The positively charged atom or group of atoms is termed as **cation**.

Na	→	Na^+	+	e^-	
Sodium atom		Sodium ion		Electron	
K	→	K^+	+	e^-	
Potassium atom		Potassium ion		Electron	
Ca	→	Ca^{2+}	+	$2e^-$	
Calcium atom		Calcium ion		Electron	
Al	→	Al^{3+}	+	$3e^-$	
Aluminium atom		Aluminium ion		Electron	

Informative

- Hydrogen atom (protium) has only one proton in its nucleus and only one electron around the nucleus.
- When it loses electron, the leftover particle is only the proton, therefore, hydrogen ion is also termed as proton.
- When a molecule of ammonia (NH_3) gains a proton (H^+), it forms ammonium ion (NH_4^+).
- When a water (H_2O) molecule gains a proton (H^+), it forms oxonium ion (H_3O^+).

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The positively charged atom or group of atoms is termed as cation.

Cl (Chlorine atom) + e^- (Electron) → Cl^- (Chloride ion)

Br (Bromine atom) + e^- (Electron) → Br^- (Bromide ion)

O (Oxygen atom) + $2e^-$ (Electron) → O^{2-} (Oxide ion)

N (Nitrogen atom) + $3e^-$ (Electron) → N^{3-} (Nitride ion)

Table 6.1 Some common ions

Positive Ions		Negative Ions	
Hydrogen ion	H^+	Fluoride ion	F^-
Silver ion	Ag^+	Iodide ion	I^-
Cuprous ion	Cu^+	Hydroxide ion	OH^{--}
Cupric ion	Cu^{2+}	Sulphide ion	S^{2-}
Calcium ion	Ca^{2+}	Sulphate ion	SO_4^{2-}
Magnesium ion	Mg^{2+}	Carbonate ion	CO_3^{2-}
Zinc ion	Zn^{2+}	Bicarbonate ion	HCO_3^-
Cobalt ion	Co^{2+}	Nitrate ion	NO_3^-
Nickel ion	Ni^{2+}	Phosphate ion	PO_4^{3-}
Ferrous ion	Fe^{2+}	Carbide ion	C^{4-}
Ferric ion	Fe^{3+}	Chlorate ion	ClO_3^-
Chromium ion	Cr^{3+}	Acetate ion	CH_3COO^-
Bismuth ion	Bi^{3+}		

6.2 VALENCY

Atoms except noble gases have unstable electronic configuration and they cannot exist independently. In order to get their electronic configuration stable, they tend to gain electron(s) or lose electron(s). For this tendency, they combine with other atoms and form molecules or formula units which can exist independently.

The combining capacity of atoms with other atoms is called **valency**. Hydrogen atom can donate one electron or gains one electron to get its electronic configuration stable. As It can donate one electron, it has one unit capacity to be combined with another atom. Hence, its valecy is one (1). Valency of an element is also defined as the number of hydrogen atoms that can combine or displace with one atom of that element.

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For example; valency of chlorine is 1, as it combines with one hydrogen atom to form hydrogen chloride (HCl). Valency of oxygen is 2, as it combines with two hydrogen atoms to form water (H_2O). Valency of nitrogen is 3, as it combines three hydrogen atoms to form ammonia (NH_3). Similarly, valency of carbon is 4, as it combines with four hydrogen atoms to form methane (CH_4).

Valency of an ion or radical is equal to the magnitude of charge on it. For example, valency of sodium ion(Na^+) is 1+, valency of chloride ion (Cl^-) is 1–. Valency of calcium ion (Ca^{2+}) is 2+ and valency of oxide ion (O^{2-}) is 2–.

3.2.1 Chemical Formula

A symbolic representation of one molecule of an element or a compound is called chemical formula. The chemical formula of a substance shows the number and kinds of atoms present in its one molecule or formula unit. Symbols show the kinds of atoms and subscript numbers show the number of atoms present. For example H_2 is the chemical formula of hydrogen. It shows that each molecule of hydrogen gas contains two hydrogen atoms. Similarly H_2O is the chemical formula of water. It shows that each molecule of water contains two atoms of hydrogen and one atom of oxygen chemically combined together.

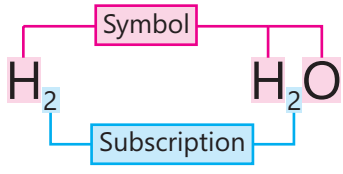

Table 6.2 Chemical Formulae of some elements and compounds

Positive Radicals / Positive Ions		Negative Radicals / Negative Ions	
Hydrogen	H_2	Water	H_2O
Oxygen	O_2	Carbon dioxide	CO_2
Nitrogen	N_2	Ammonia	NH_3
Fluorine	F_2	Methane	CH_4
Chlorine	Cl_2	Hydrochloric acid	HCl
Bromine	Br_2	Sulphuric acid	H_2SO_4
Iodine	I_2	Glucose	$C_6H_{12}O_6$

How to write a formula

For ionic compounds oppositely charged ions give shape to the formula. Following is the procedure for writing a chemical formula.

1. Write the symbols of oppositely charged ions side by side, the positive ion to the left and negative ion to the right.
2. Cross the valencies to the lower right of each ion. If valencies are equal, don't cross, as they cancel each other.

Example: Write down the formulae of sodium sulphate and aluminium chloride.

Step 1: According to rule 1 write down the positive ion on the left hand side and negative ion on the right hand side.

Na^+ SO_4^{-2} Al^{3+} Cl^-

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Step 2: Cross the valencies to set the formula.

Hence the formulae of sodium sulphate and aluminium chloride are:

Na_2SO_4	$AlCl_3$
Sodium sulphate	Aluminium chloride

Activity 6.2 Assessment

Write the chemical formulae of different compounds using oppositely charged ions given below in the **Table** . Write name of the compound also. An example is shown.

Positive and negative radicals

Cations ↓ / Anions →	Cl^- Chloride ion	O^{-2} Oxide ion	NO_3^{-1} Nitrate ion	SO_4^{-2} Sulphate ion
Na^+ Sodium ion	NaCl Sodium Chloride	Na_2O Sodium oxide	$NaNO_3$ Sodium Nitrate	Na_2SO_4 Sodium Sulphate
K^+ Potassium ion				
NH_4^+ Ammonium ion				$(NH_4)_2SO_4$ Ammonium Sulphate
Ca^{+2} Calcium ion			$Ca(NO_3)_2$ Calcium Nitrate	
Mg^{+2} Magnesium ion				
Zn^{+2} Zinc ion				
Fe^{+2} Ferrous ion				
Al^{+3} Aluminium ion				
Cr^{+3} Chromium ion				

Cations ↓ / Anions →	Br^- Bromide ion	S^{-2} Sulphide ion	CO_3^{-2} Carbonate ion	HCO^{3-} Bicarbonate ion
Na^+ Sodium ion				
Mg^{+2} Magnesium ion				
Bi^{+3} Bismuth ion				
Ba^{+2} Barium ion				

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6.3 CHEMICAL BOND

Atoms attain stability by having 2 or 8 electrons in the outermost shell like noble gases. For this tendency atoms combine with other atoms forming chemical bonds. A chemical bond is a force of attraction between atoms that holds them together in a substance. Chemical bonds are formed in three ways:

1. By donating valence shell electrons to other atoms.
2. By gaining electrons from the valence shell of other atoms.
3. By mutual sharing of valence shell electrons between the atoms.

Types of chemical bond

Chemical bonds are of two types:

- Ionic bond
- Covalent bond

6.3.1 ionic Bond

A chemical bond formed by complete transfer of electron from one atom to another atom is called ionic bond **(Figure 6.4)**. This bond is formed when one atom loses electron from its outermost shell and the other atom gains this electron in its outermost shell. The atom losing electrons forms a positively charged ion (cation) and the atom gaining electron forms a negatively charged ion (anion).

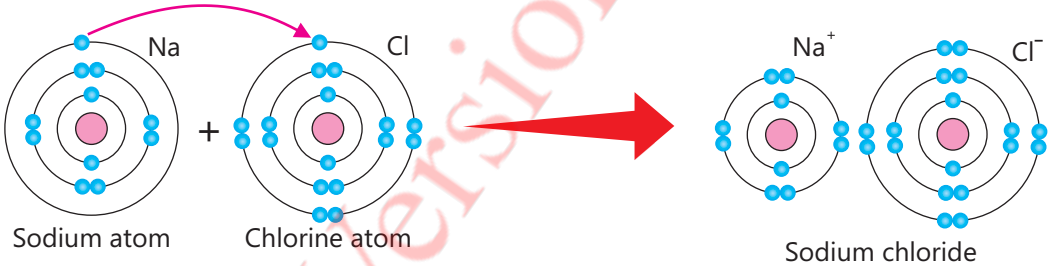

Figure 6.4 Ionic bond between sodium and chloride ions

Na (Sodium atom) $\longrightarrow$ Na^+ (Sodium ion) + $1e^-$ (Electron)

Cl (Chlorine atom) + e^- (Electron) $\longrightarrow$ Cl^- (Chloride ion)

Na^+ (Sodium ion) + Cl^- (Chloride ion) $\longrightarrow$ $NaCl$ (Sodium chloride)

Ionic bonds are formed between metallic and non-metallic atoms. This is because, metals have a tendency to lose their outermost shell electrons to form positively charged ions (cations). Whereas, non-metals have a tendency to gain electrons in their outermost shell to form negatively charged ions (anions). Cations and anions are oppositely charged ions having electrostatic force of attraction between them making/forming ionic bond.

6.3.2 Covalent Bond

A chemical bond formed by mutual sharing of electrons between bonded atoms is called covalent

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bond. Covalent bonds are of three types:

1. Single covalent bond
2. Double covalent bond
3. Triple covalent bond

1. Single covalent bond

A covalent bond formed by mutual sharing of one electron pair between bonded atoms is called single covalent bond. It is denoted by one dot pair or cross pair or dot and cross pair or one short line between the bonded atoms.

Example:

Hydrogen atom has one electron in its outermost shell. Two hydrogen atoms combine through a single covalent bond in which each atom equally contributes one electron in a mutually shared electron pair (**Figure 6.5)**.

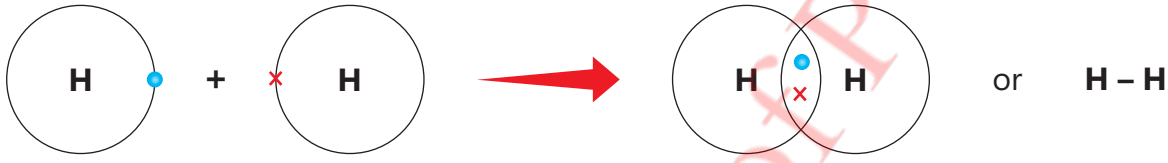

Figure 6.5 Single covalent bond

Other examples of single covalent bond are Cl_2, HCl, H_2O, etc.

2. Double covalent bond

A covalent bond formed by mutual sharing of two electron pairs between bonded atoms is called double covalent bond. It is denoted by two dot pairs or cross pairs or dot and cross pairs or two short lines between the bonded atoms.

Example:

Oxygen atom has six electrons in its outermost shell. Two oxygen atoms combine through a double covalent bond in which each atom equally contributes two electrons forming two mutually shared electron pairs **(Figure 6.6)**.

Figure 6.6 Double covalent bond

Other example of double covalent bond is CO_2.

3. Triple covalent bond

A covalent bond formed by mutual sharing of three electron pairs between bonded atoms is called triple covalent bond. It is denoted by three dot pairs or cross pairs or dot and cross pairs or three short lines between the bonded atoms.

Example:

Nitrogen atom has five electrons in its outermost shell. Two nitrogen atoms combine through a

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triple covalent bond in which each atom equally contributes three electrons forming three mutually shared electron pairs **(Figure 6.7)**.

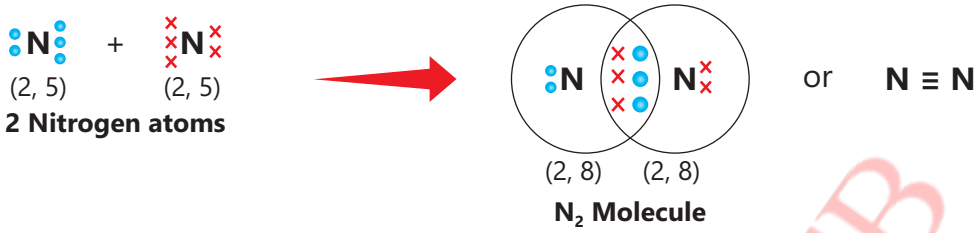

Figure 6.7 Triple covalent bond

KEY POINTS

- The charged particle (atom or group of atoms) is called ion.
- The positively charged atom or group of atoms is termed as cation.
- The negatively charged atom or group of atoms is termed as anion.
- When an atom or group of atoms gains or loses electrons, it acquires charge. The charged particle is called ion.
- The combining capacity of an element is called valency.
- A symbolic representation of one molecule of an element or a compound is called its formula.
- A chemical bond is a force of attraction between atoms that holds them together in a substance.
- A chemical bond formed by complete transfer of electron from one atom to another atom is called ionic bond.
- A covalent bond formed by mutual sharing of one electron pair between bonded atoms is called single covalent bond.
- A covalent bond formed by mutual sharing of two electron pairs between bonded atoms is called double covalent bond.
- A covalent bond formed by mutual sharing of three electron pairs between bonded atoms is called triple covalent bond.

QUESTIONS

6.1 Encircle the correct option.

1. A molecule consists of two or more

a. compounds b. atoms c. formulae d. elements

2. Which of the following is a cation?

a. H_2 b. H_2O c. CO_2 d. NH^{+4}

3. Which of the following is an anion?

a. F b. Cl c. S^{2-} d. NH_3

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4. Oxygen is a:

a. monovalent element b. divalent element
c. trivalent element d. tetravalent element

5. Chemical bond between N_2 molecule is:

a. ionic b. single covalent
c. double covalent d. triple covalent

6. How many atoms form one molecule of chlorine gas?

a. 1 b. 2 c. 3 d. 4

7. Outermost shell of sodium atom has _____electron(s):

a. 1 b. 2 c. 3 d. 4

8. Outermost shell of chlorine atom has _____ electrons:

a. 1 b. 2 c. 6 d. 7

9. Which of the following has stable electronic configuration?

a. H b. He c. C d. Li

10. Which of the following has double covalent bond?

a. Br_2 b. CO_2 c. HCl d. N_2

6.2 Define the following and explain with examples.

1. Valency
2. Ion
3. Formula
4. Bond
5. Electronic configuration

6.3 Answer the following questions.

1. Write the symbols for the following:
   Copper, iron, chlorine, potassium, argon, phosphorus, beryllium, carbon, calcium, silicon.
2. Write the chemical formulae of the following:
   Sodium bicarbonate, calcium hydroxide, ammonia, potassium chloride, acetic acid, ammonium hydroxide, sulphuric acid, nitric acid, benzene, methane.
3. In what way the molecule of an element is different from that of a compound?
4. State the number and kinds of atoms present in carbon tetrachloride (CCl4)?
5. Differentiate the following
   (a) Symbol and formula (b) Positive ion and negative ion.

6.4 Investigate the metallic bond.

6.5 Project: Construct models to explain ionic and covalent bonds using low cost or no cost material.

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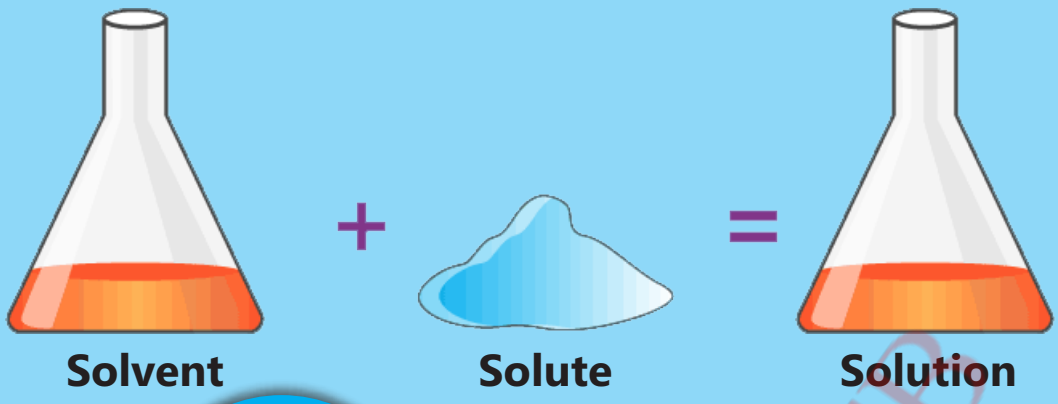

What is solute?

What is solvent?

How are solutions important?

07 Solutions

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Students' Learning Outcomes

After studying this chapter, students will be able to:

- Demonstrate the process of solution formation (using water as universal solvent).
- Distinguish among solute, solvent and solution; saturated and unsaturated solution.
- Define solubility.
- Recognize that the amount of solute which dissolves in a given solvent has an upper limit.
- Identify the factors which affect the solubility of a solute in a solvent and recognize the importance of these factors in homes and industries.
- Explain what is meant by a concentrated and dilute solution.
- Identify ways of accelerating the process of dissolving materials in a given amount of water and provide reasoning (i.e., increasing the temperature, stirring, and breaking the solid into smaller pieces increases the process of dissolving).
- Explore the effectiveness of various cleaning solutions in cleaning tarnished and oxidized coins (STEAM)
- Make a rock candy with sugar using crystal seeding technique (STEAM).

VOCABULARY

Solute	Solvent	Solution	Aqueous solution	Saturated solution	Unsaturated solution
The component of a solution present in smaller quantity	The component of a solution present in large quantity	Homogeneous mixture of two or more substances	Solution of a substance in water	Solution to which no more solute can be dissolved at a particular temperature	Solution to which further amount of solute can be dissolved at a particular temperature

Recall what you have learnt

Solutions

When a teaspoon of sugar is added to a glass of water and stirred, sugar dissolves in water producing a homogeneous mixture. A homogeneous mixture of two or more substances is called a **solution (Figure 7.1)**. A solution, which is prepared by mixing only two substances, is called a **binary solution**.

Examples

Solution of salt in water, solution of sugar in water, solution of bromine in water, etc.

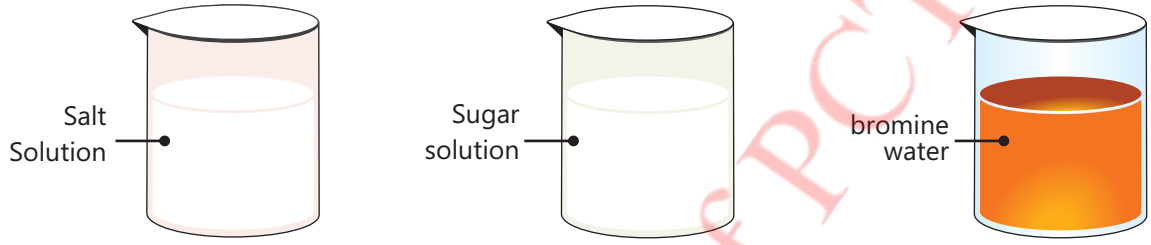

Fig. 7.1 Binary solutions

Components of Solution

A binary solution consists of two components

(i) Solute (ii) Solvent

(i) Solute

The solute is a substance that dissolves. In a binary solution, solute is that component of the solution which is present in smaller quantity. e.g. In a 5% sugar solution in water, sugar is the solute.

(ii) Solvent

The solvent is the substance in which the solute or solutes dissolve(s) and it forms the bulk of the solution **(Figure 7.2)**. In a binary solution, solvent is that component of the solution, which is present in large quantity. e.g., In a 5% sugar solution in water, water is the solvent.

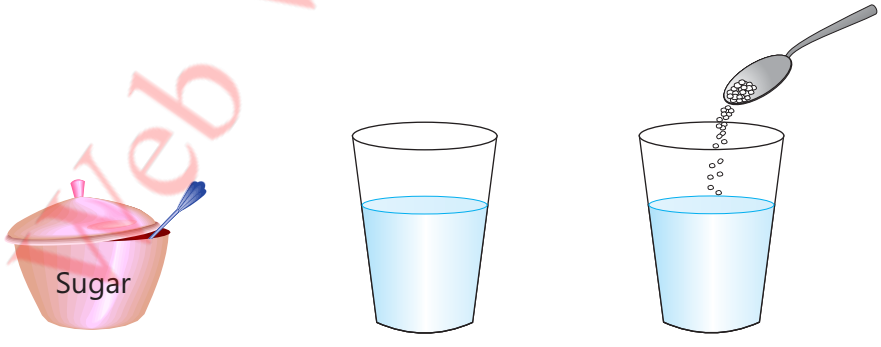

Fig. 7.2 Solute, solvent and solution.

Most common solvents are liquids like water, alcohol, petrol, carbon disulphide, mercury, etc.

A solution is named on the name of the solute. e.g. 5% sugar solution in water will be named as sugar solution.

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Aqueous Solutions

A solution in which water is used as a solvent is called aqueous solution (aqua means water). Water is the most common and widely used solvent. It is known as an excellent solvent because it can dissolve a large variety of substances in it due to its strong solvent action. However, there are many substances like grease, paint and some inks etc., which cannot dissolve in water. They can dissolve in other types of solvents such as alcohol, petrol and propane, etc. That is why we cannot wash off grease or paint stains with water.

Types of Solutions

The most common solutions are those in which, a solid, a liquid or a gas is dissolved in a liquid solvent. However, there are many other solutions, which are formed by dissolving a solid in another solid, a liquid in another liquid, a gas in another gas or by other combinations of the three physical states of matter. **Table 7.1** shows some examples of different types of solutions.

Table 7.1 Different types of solutions

State of solute	State of solvent	Examples of solution
Solid	Liquid	1. Salt solution (salt dissolved in water) 2. Amalgam (tin, gold or copper dissolved in mercury)
Liquid	Liquid	Alcoholic drinks (alcohol dissolved in water)
Gas	Liquid	1. Fizzy drinks (carbon dioxide dissolved in water) 2. Sea and river water (oxygen dissolved in water)
Gas	Gas	Air (oxygen, carbon dioxide, noble gases dissolved in nitrogen)
Solid	Solid	1. Brass (zinc dissolved in copper) 2. Bronze (tin dissolved in copper)

Particle Model of Solutions

On dissolving in the solvent, the solute is broken down into tiny particles like atoms, molecules or ions that are mixed completely and evenly with the particles of the solvent **(Figure 7.3)**. That is why

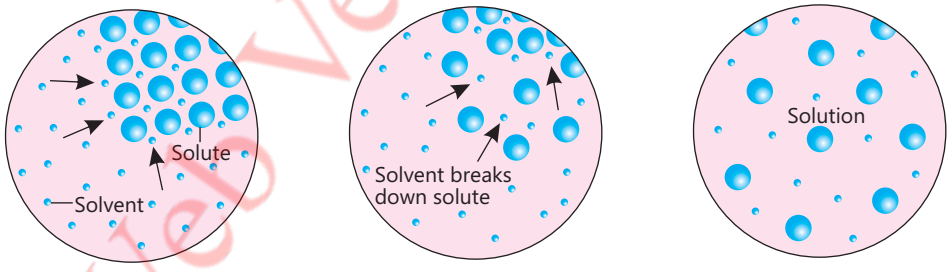

Figure 7.3 When a solute dissolves in the solvent

a solution is a homogeneous mixture. Its colour, density, appearance and other physical and chemical properties are the same in every part of the solution. Its composition is uniform and tiny solute particles, which are spread out evenly in the solvent are too small to reflect or block any light passing through the solution. Hence, if we shine a beam of light through a solution, the light will pass through the solution **(Figure 7.4)**.

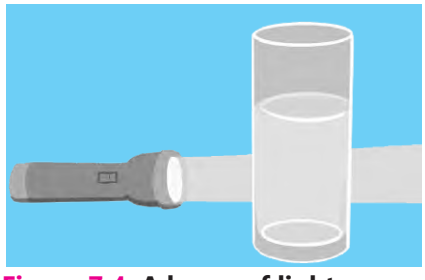

Figure 7.4 A beam of light passes through a salt solution

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The solute particles dissolved in a solution are also too small that they are passed through the filter paper and no residue is left behind when we filter a solution **(Figure 7.5)**.

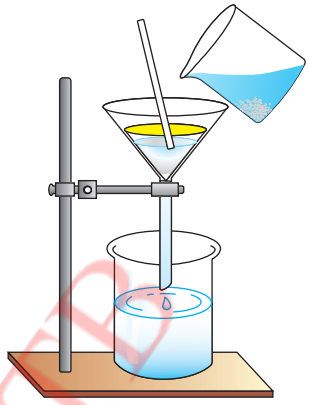

Figure 7.5 No residue is left behind when a solution is filtered

Strength or concentration of solutions

The strength or concentration of a solution depends upon the quantity of solute dissolved in the solution.

Activity and inquiry based learning

Activity 7.1

Take two glasses and mark them at the middle with a marker. Fill the glasses with water up to the mark. Add half teaspoonful of sugar in glass 1 and one teaspoonful of sugar in glass 2. Stir the two solutions well and record your observations.

Q. No.	Inquiry	Reply
1	Which solution is sweeter?	Solution in glass 2 is sweeter than solution in glass 1.
2	Which solution is stronger?	The solution in glass 2 is stronger than the solution in glass 1.
3	Why is the solution of glass 2 sweeter than that of glass 1?	Because the solution in glass 2 has greater amount of sugar dissolved in it than the solution in glass 1.

Dilute and concentrated solutions

A solution, which contains relatively less amount of solute, dissolved in a large amount of solvent is called a dilute solution or weak solution. For example, a solution of 1g sugar dissolved in 500 cm^3 water is a dilute solution than a solution of 20 g sugar dissolved in 500 cm^3 water.

A solution, which contains relatively large amount of solute dissolved in the same amount of solvent, is called concentrated solution or strong solution. For example, a solution of 20 g sugar dissolved in 500 cm^3 water is a concentrated solution than a solution of 1 g sugar dissolved in 500 cm^3 water.

The number of dissolved solute particles in a concentrated solution is more than that in a dilute solution of equal volume.

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Activity 7.2 Assessment

Write C against the correct and I against the incorrect statement in the middle column. Also correct the incorrect statement and write it in the next column.

Correct/Incorrect	C/I	Correct statement
A solution which is prepared by mixing only two substances, one is solute and the other is solvent is called binary solution.		
A solution can be diluted by adding more solute into it.		
A solution is a pure matter.		
Stainless steel is a solution.		

In this chapter we will learn about:

- Saturated and Unsaturated solutions
- Ways of accelerating the process of dissolving materials
- Solubility

7.1 UNSATURATED AND SATURATED SOLUTIONS

Depending upon the amount of solute dissolved, the solutions can be classified as unsaturated, saturated and super-saturated solutions.

Unsaturated solution

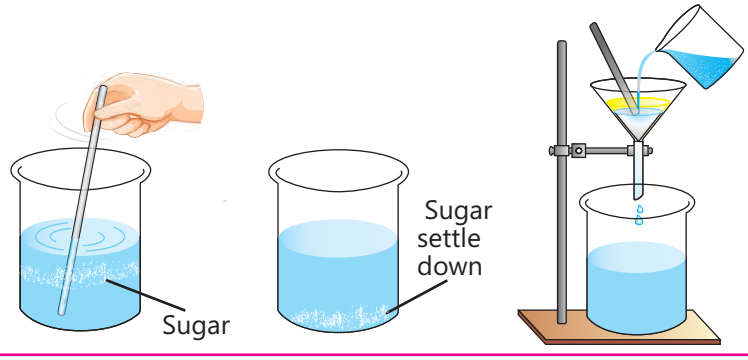
If 5 g salt is added to 500 cm^3 of water in a beaker and stirred, it will dissolve in the water. If some more salt is added to this solution, it will also be dissolved. Such a solution to which further amount of the solute can also be dissolved at a particular temperature is called unsaturated solution.

Saturated solution

If some salt is added to 500 cm^3 of water in a beaker and stirred, it will dissolve in water. If more salt is added to the solution and stirred, there will be a time when the salt will not dissolve anymore. **Such a solution to which no more solute can be dissolved at a particular temperature is called a saturated solution.** If more solute is added at the same temperature, the excess remains undissolved at the bottom of the container.

Activity 7.3

Take 100g of water in a beaker. Add half teaspoon full of sugar and stir. Keep on adding sugar and stirring until the sugar starts settling down at the bottom of the beaker. Filter the solution in another beaker. Keep it at room temperature. This solution is called saturated solution of sugar at room temperature.



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	Questions	Answers
1	What type of solution is this at room temperature?	This is a saturated solution of sugar at room temperature.
2	Can you dissolve more sugar in it?	If temperature does not change, no more sugar will dissolve into it.
3	What will happen if you add some more sugar into this solution?	Sugar will remain undissolved and settle at the bottom of the beaker.

7.2 SOLUBILITY

A substance, which can be dissolved in a solvent, is said to be soluble in that solvent. A substance, which cannot be dissolved in a solvent, is said to be insoluble in that solvent. For example salt is insoluble in oil but soluble in water.

Do you know there is a limit to the quantity of salt, which can be dissolved in 100 g water at room temperature?

Yes, no more solute would dissolve, when the solution becomes saturated at a particular temperature. Different substances have different capabilities to be dissolved in the same solvent at a particular temperature.

For example; Sodium nitrate ($NaNO_3$) is more soluble in water than silver chloride (AgCl). Similarly, sulphur dioxide (SO_2) is more soluble in water than carbon dioxide (CO_2). Different solvents have different solvent-actions for the same solute to dissolve them. For example, naphthalene is more soluble in benzene than in water. Solubility of a substance (solute) in a solvent is defined as:

> "The maximum amount of a solute required to saturate 100 g of a solvent at a particular temperature is called solubility of the solute in the solvent."

7.2.1 Factors Affecting Solubility

Following are the factors that affect solubility:

- Nature of the solute and solvent
- Temperature of the solution.
- Pressure.

Nature of solute and solvent

The principle of dissolution is that like dissolves like. Water has ionic character. The ionic compounds like sodium chloride, silver nitrate, silver chloride, etc. are dissolved in water. The covalent compounds are dissolved in covalent solvent.

Temperature

Generally, an increase in temperature of the solution increases the solubility of a solid solute. For example, greater amount of sugar is dissolved in hot water than in cold water. Solubility of gases decreases with the increase in temperature of the solution. For example, solubility of carbon dioxide in soda water decreases when temperature increases.

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Pressure

Pressure affects the solubility of gaseous solutes in liquid solvents. Carbon dioxide is dissolved in soda water. When the cap on the soda bottle is opened, the pressure on the solution is released and carbon dioxide dissolved under pressure begins to bubble out.

Inquiry 7.1

Teacher Guide

Facilitate students:

- Test the solubility of common salt in cold water and in hot water.
- Conduct an interactive discussion and conclude whether the solubility of common salt in water increases or decreases with the increase in temperature.

How does solubility affect everyday life?

There are many practical applications of solubility in daily life, especially in industries. A few are mentioned below:

1. In carbonated drinks, carbon dioxide remains dissolved in water due to its solubility in water.
2. Paints are dissolved in the solvents like alcohol and ether, etc. These solvents help to dry the paint.
3. Water soluble dyes are used in textile industry on greater scale as dyes (coloured substances) are used to create colourful patterns on clothes.
4. Solubility is very important in pharmaceutical industry. It is helpful to achieve the desired concentration of the drugs in solutions.
5. Use of solubility parameters is very important in petroleum industry.

Informative

Gold is stable even to strong acids. A special mixture of nitric acid and hydrochloric acid can dissolve it. This mixture is known as "aqua regia", which is a Latin for "royal water", because of its special ability to dissolve gold.

7.3 WAYS OF ACCELERATING THE PROCESS OF DISSOLVING MATERIALS

Size of the solute particles, stirring the solution and the temperature, etc., are the ways used to accelerate the process of dissolving materials.

Stirring

Activity 7.4

Teacher Guide

Facilitate students to:

- Conduct the following activity to prove the hypothesis:

Hypothesis

"The mixture that is stirred dissolves faster than the mixture that is not stirred."

1. Take two equal sized beakers.
2. Label them as **A** and **B**.
3. Fill each beaker with 100 mL water.

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4. Add one teaspoon full of sugar in each beaker.
5. Stir the sugar added in beaker **A** with the help of a stirrer.
6. Don't stir the sugar added in beaker **B**.
7. Observe both the mixtures.
8. What do you conclude?

Conclusion:

_____

_____

Size of the particles

Activity 7.5

Teacher Guide

Facilitate students to:

- Conduct the following activity to prove the hypothesis:

Hypothesis

"Fine salt dissolves faster than the coarse salt."

1. Take two equal sized beakers.
2. Label them as **A** and **B**.
3. Fill each beaker with 100 mL water.
4. Add one teaspoon full of table salt in beaker **A**.
5. Add one teaspoon full of rock salt in beaker **B**.
6. Stir the mixture in beaker A and note time the salt takes to dissolve completely.
7. Now stir the mixture in beaker **B** and note time the salt takes to dissolve completely.
8. Which salt takes more time to dissolve?
9. What do you conclude?

Conclusion

_____

_____

Activity 7.6

Teacher Guide

Facilitate students to:

- Conduct the following activity to prove the hypothesis:

Hypothesis

"Rate of dissolution can be increased by increasing the temperature."

1. Take two equal sized beakers.
2. Label them as **A** and **B**.
3. Fill beaker **A** half with cold water.

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4. Fill beaker **B** half with hot water.
5. Add one teaspoon full of sugar in beaker **A**.
6. Add one teaspoon full of sugar in beaker **B**.
7. Stir the mixture in beaker **A** and note time the salt takes to dissolve completely.
8. Now stir the mixture in beaker **B** and note time the salt takes to dissolve completely.
9. What do you conclude?

Conclusion

_____

_____

Activity 7.7 Use of solutions for cleaning tarnished or oxidized coins

- Take a small beaker and fill it half with vinegar solution.
- Dip the tarnished or oxidized coins in the vinegar solution for 30 minutes .
- Remove the coins and gently scrub the residue over them with the toothbrush.
- Rinse the dirt off with water and dry with a cloth.
- Get the tarnished or oxidized coins clean.

KEY POINTS

- A solution to which further amount of the solute can also be dissolved at a particular temperature is called unsaturated solution.
- A solution to which no more solute can be dissolved at a particular temperature is called a saturated solution.
- The maximum amount of a solute required to saturate 100 g of a solvent at particular temperature is called solubility the solute in that solvent.
- Nature of solute and solvent, temperature and pressure, etc., are the factors affecting the solubility.
- Size of the solute particles, stirring the solutions and the temperature, etc., are the ways used to accelerate the process of dissolving materials.

QUESTIONS

7.1 Encircle the correct option.

1. Which of the following is insoluble in water?

a. sodium chloride
b. oil
c. table salt
d. baking powder

2. A solution to which no more solute can be dissolved at a particular temperature is called:

a. dilute solution
b. concentrated solution
c. saturated solution
d. unsaturated solution

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3. **A concentrated solution can dissolve in it:**
   a. no further amount of solute
   b. less quantity of solute
   c. large quantity of solute
   d. amount of solute equal to the amount of solvent

4. **Amount of solute required to saturate 100 g of solvent at a particular temperature is called:**
   a. molarity b. molality c. normality d. solubility

5. **A solution having relatively less amount of solute dissolved in it is called:**
   a. dilute solution b. binary solution
   c. concentrated solution d. saturated solution

7.2 Define the followings:

1. Binary solution
2. Aqueous solution
3. Solute
4. Homogeneous mixture
5. Unsaturated solution

7.3 Constructed Response Questions

1. Describe preparation of a solution.
2. Describe the factors affecting the solubility.
3. Explain the effect of temperature on the solubility of table salt in water.
4. Describe the importance of solutions in daily life.
5. How can we increase the process of dissolution?

7.4 Investigate the importance of solubility in textile and pharmaceutical industries.

7.5 Project: Prepare rock candy

Teacher Guide

Facilitate students to prepare rock jelly.

Procedure

- Dip a few bamboo sticks in water for a few minutes.
- Roll each stick in the pot containing sugar.
- Fill some jars with hot saturated sugar solution.
- Add food colour and flavor of your choice in sugar solution taken in jars.
- Submerge the bamboo sticks separately in each jar.
- Remove the sticks from the jars after 5 to 6 days.
- Enjoy the candy.

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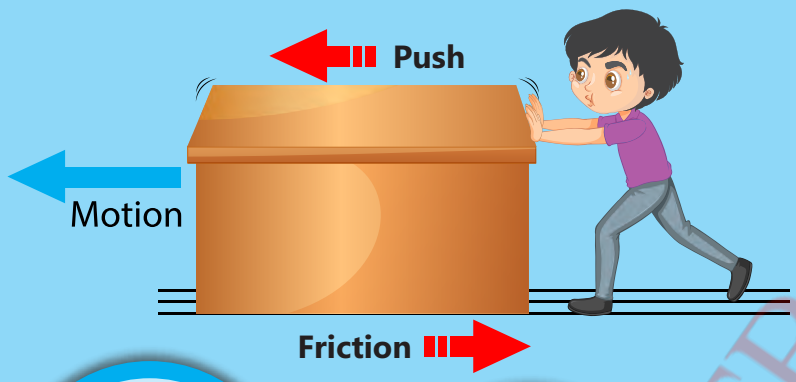

What makes the things at rest move?

What makes the moving objects stop motion?

What is gravitational acceleration?

08 Force and Motion

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Students' Learning Outcomes

After studying this chapter, students will be able to:

- Describe the effect of force on changing the speed and direction of motion with time.
- Define and state the SI unit of force.
- Formulate the relationship between speed, distance and time.
- State SI (System International) unit of speed.
- Calculate average speed.
- Interpret a distance-time graph.
- Give examples of contact forces and non-contact forces.
- Demonstrate that forces always work in action and reaction pairs (equal in magnitude, opposite in direction).

VOCABULARY

Force	Distance	Speed	Gravity	Displacement	N (newton)
Push, pull, friction, gravity, etc.	Measure of how far apart objects or points are	Measure of how fast or slow an object moves per unit time	The Earth's pull on objects	Shortest distance between two points	Standard quantity or unit used for measuring force

Recall what you have learnt

We have learnt:

- The act of push and pull
- Gravity
- Friction

Figure 8.1 given below will help you recall what you have learnt about force.

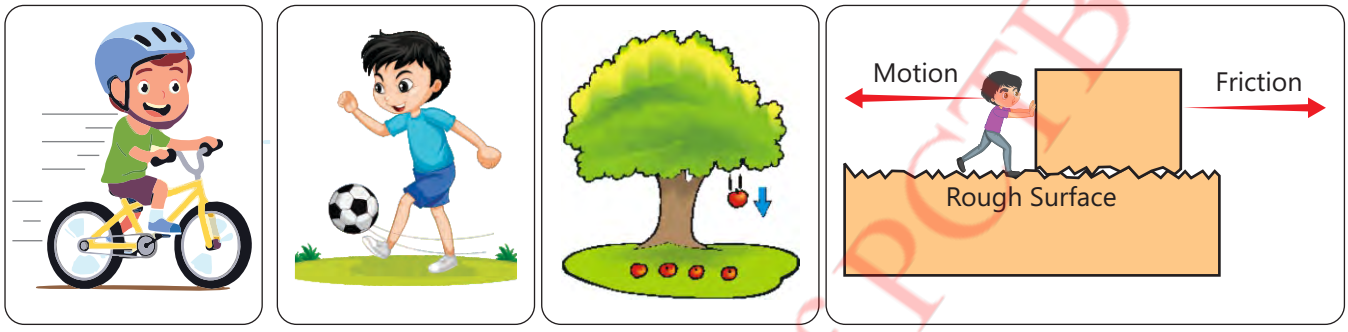

Figure 8.1 Examples of force

Activity 8.1 Assessment

Write **C** against the correct and **I** against the incorrect statement in the middle column. Also correct the incorrect statement and write it in the next column.

Correct/Incorrect	C/I	Correct statement
Kicking a football is application force on it		
Whatever is thrown upward, return to the ground is due to the Earth's push on the objects. .		
Force makes the thing at rest move.		
Friction stops or tends to stop the moving objects.		
Machines make the work easier.		

In this chapter we will learn about:

- Force
- Unit of force
- Relationship between speed, distance and time
- Contact forces and non-contact forces

8.1 FORCE

Push and pull makes the things move. Gravity is the Earth's pull on the objects. Moving objects cannot stop if there is no friction. Push and pull, gravity and friction are the examples of the force.

8.1.1 Effects of Force

Force can **(Figure 8.2)**:

- make the things at rest move.
- stop the moving objects.

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- change the speed of a moving object.
- change the direction of a moving object.
- change the shape of an object.

Force makes the objects move

Force stops the moving object

Force changes the speed

Force changes the shape of object

Force changes the direction of motion

Figure 8.2 Effects of force

8.1.2 Change in speed

Consider you are moving by a bicycle at certain speed. If your friend pushes the bicycle from behind, the speed of your bicycle will increase and it will move faster. If he pulls your moving bicycle from behind, the speed of bicycle will decrease and you will move slower.

If a force is applied on a moving object in the direction of motion, its speed increases. If the force is applied in the direction opposite to the direction of motion of the object, its speed decreases.

8.1.3 Change in direction

In a cricket match, when the bowler throws ball towards batsman, he hits the ball. In this way, the direction of motion of the ball is changed. The force exerted by the batsman on the moving ball changes its direction of motion.

Do you know?

1. The quantity of matter in an object is called its mass (m)
2. The Earth pulls the things towards itself. The Earth's pull on the objects is called gravity.
3. How fast things move towards the Earth is termed as acceleration due to gravity (g). The value of 'g 'is taken as 10 N/kg.
4. The quantities of mass, force, length, time, etc., that can be measured are called physical quantities.
5. The standard quantity used to measure that quantity is called its unit.
6. According to International System of Units, called Standard International (SI):
   - The standard quantity of mass used to measure it is kilogram (kg). Hence, SI unit of mass is kilogram (kg). Gram (g), milligram (mg), etc. are smaller units of mass.

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- The standard quantity of length or distance used to measure it is kilometre (km). Hence, SI unit of length or distance is kilometre (km). Metre (m), millimetre (mm), etc. are smaller units of length or distance.
- The standard quantity of time used to measure it is second (s). Hence, SI unit of time is second (s). Minute (min), Hour (hr), etc., are the bigger units of time.

8.2 UNIT OF FORCE

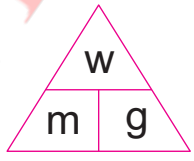
Force is a physical quantity. The Standard International (SI) unit of force is newton. The symbol used for newton is 'N'.

Weight is a force. In fact, it is the gravitational force acting on an object. The symbol used for weight is 'w'. If 'm' is mass is of an object and 'g' is the acceleration due to gravity having value (10 N / kg), then we can express weight as:

$$w = mg \quad \ldots\ldots\ldots \quad (1)$$

The weight (force) acting on an object of mass 1 kg can be calculated using equation (1) as:

$$w = mg$$
$$w = 1\ (kg) \times 10\ N/kg$$
$$w\ (force) = 10\ N$$



Thus, the weight (force) of 1 kg mass on the Earth is 10 N.
It means weight (force) of 1000 g mass = 10 N.
The weight (force) of 100 g mass = 1 N

The standard one newton force is the force (weight) that the Earth acts on an object of mass 100 g.

Problem 8.1: Calculate the weight (force) of an object having mass 5 kg on the Earth's surface.

Solution:

m (mass) = 5 kg
g = 10 N/kg
w = mg
w = 5 kg × 10 N/ kg
w = 50 N

Mini Exercise

Calculate the weight of an object of mass 10 kg on the surface of the Earth.

Test yourself!

What will be the weight of an object of mass 10 kg on the moon, where value of g is 1.6 N/kg.

Think Tank

Suppose the spherical shape of the Earth as shown in the Figure. Person 'A' is standing on the ground in Pakistan.

(i) Which country is opposite to Pakistan on the Earth's surface?

(ii) Why doesn't the person 'B' standing on the ground in Brazil fall away into the space from the Earth?

(iii) What is the direction of the Earth's gravitational force or gravity?

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Informative

An English scientist, Sir Isaac Newton (1642 – 1727) was the first who understood the gravitational force.

Brain teaser

Suppose a metallic block consists of ten billion particles. If we take it on the moon, how many particles does it consist of at the moon?

The position where the same force of gravity acts on two objects of different masses, the object with bigger mass has the greater weight.

8.2.1 Newton – The Unit of Force

The SI unit of force is **Newton (N)**. It is named after the English Scientist Sir Isaac Newton. On the Earth, a body of mass 100g has a weight of about 1 N. For example, a medium sized apple has a mass about 100g. The gravitational pull on this apple is 1 N approximately, i.e., its weight is 1 N.

The Earth's gravitational field strength (g) is 10 N/kg. This means that for each kg of mass, an object will experience 10 N of force.

The gravitational acceleration (g) is a constant and equal to 9.8 meter per second square (ms^{-2}).

Problem 8.2: Calculate the weight of a wooden block of mass 45 kg. The value of g = $10ms^{-2}$.

Solution:

Mass of the block (m)	=	45 kg
Gravity acting on it (g)	=	$10ms^{-2}$
Weight (W)	=	?
W	=	mg
W	=	45 kg × $10ms^{-2}$ = 450 N (Ans.)

8.2.2 Measuring Force

Force is measured by using an instrument called **force meter**. The force meter is a spring balance **(Figure 8.3)**, which is of two types; extension spring balance and compression spring balance. In an extension spring balance, when a pulling force acts on its extension, it stretches and the pointer moves along the scale, showing the value of force. In the compression spring balance, its spring compresses when a pushing force acts on it.

Figure 8.3 Spring balance

8.3 RELATIONSHIP BETWEEN SPEED, DISTANCE AND TIME

8.3.1 Force and Motion

Force is needed to make a body move. When we apply some force on an object, it moves and covers some distance in the direction of applied force.

Speed of a moving object tells us how fast or slow it moves. If you drive your vehicle at greater

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speed, you will move fast and cover more distance in a given time. If you drive the vehicle at slower speed, you will move slow and cover less distance in the given time. Speed is defined as the distance travelled per unit time.

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} \quad \ldots\ldots\ldots \quad (2)$$

This equation (2) reveals that speed is a measure of the distance, an object travels, per unit time.

If distance covered is denoted by **S**, speed by **v** and time by **t**, the equation (2) may symbolically be written as:

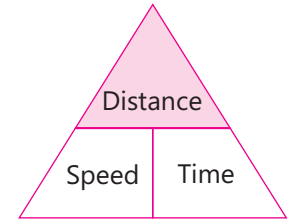
$$v = \frac{S}{t}$$

The unit for measuring speed can be derived by dividing the unit of distance kilometer (km) or metre (m) by the unit of time hours (hr) or second (s). The unit of speed is therefore kilometre per hour (km/hr or km hr^{-1}) or metre per second (m/s or m s^{-1}).

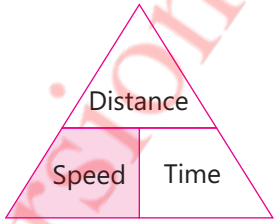
Problem 8.3: A boy runs 240 m in 80 second. Calculate its speed.

Solution: $v = \frac{S}{t} = \frac{240\ m}{80\ s} = 3\ ms^{-1}$

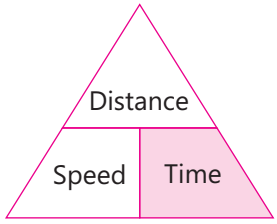
Speed, distance and time are related as under:



Distance = Speed × Time



$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$



$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$

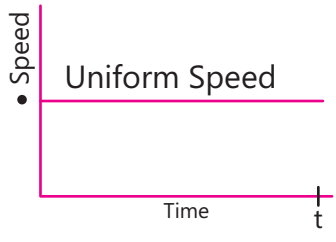
8.3.2 Types of Speed

- Uniform speed
- Variable speed
- Average speed

Uniform speed

If an object travels the same distance in the same intervals of time, its speed is called **uniform speed**.

Example: If a vehicle covers 70 km in first hour, 70 km in second hour and 70 km in third hour, its speed is uniform, i.e., 70 km/hr.



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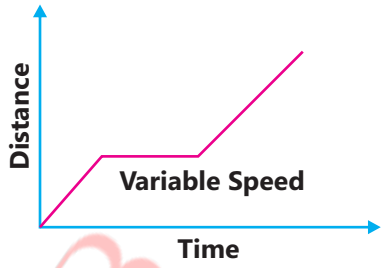
Variable speed

If a car travels different distances in the same intervals of time, its speed is called **variable speed**.



Example: If a car travels 55 km in first hour, 64 km in second hour and 75 km in third hour, the car will have variable speed.

Average speed

The speed of an object may vary during the total time it has moved. The **average speed** can be calculated by dividing the total distance an object covers by the total time it takes to cover that distance.

$$\text{Average speed} = \frac{\text{Total distance covered}}{\text{Total time taken}}$$

Problem 8.4

A person travels by car at a speed of 60 km/hr for 2 hours and then slows down to 40 km/hr for the next 2 hours. Calculate the average speed?

Solution: Suppose S_1 is the first distance and S_2 is the second distance travelled.

We know:

$$S = v \times t$$

$$S_1 = 60 \text{ km hr}^{-1} \times 2 \text{ hr} = 120 \text{ km}$$

$$S_2 = 40 \text{ km hr}^{-1} \times 2 \text{ hr} = 80 \text{ km}$$

Total distance $= S = S_1 + S_2$

$S = 120 \text{ km} + 80 \text{ km}$

$S = 200 \text{ km}$

Total time $= t = t_1 + t_2$

$t = 2 \text{ hr} + 2 \text{ hr}$

$t = 4 \text{ hr}$

$$\text{Average speed} = \frac{\text{Total distance covered}}{\text{Total time taken}}$$

$$= \frac{200 \text{ km}}{4 \text{ hr}} = 50 \text{ km hr}^{-1}$$

Problem 8.5

A student covers 80 m in 8 s and 120 m in 12 s. Calculate his average speed?

Solution:

Total distance covered $= S_1 + S_2$

$= 80 \text{ m} + 120 \text{ m}$

$= 200 \text{ m}$

Total time taken $= t_1 + t_2 = 8 \text{ s} + 12 \text{ s} = 20 \text{ s}$

$$\text{Average speed} = \frac{\text{Total distance covered}}{\text{Total time taken}}$$

$$= \frac{200 \text{ m}}{20 \text{ s}} = 10 \text{ m s}^{-1}$$

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Problem 8.6

A motor car covers 100 m in 5 seconds. If the speed is uniform, find its value.

Solution

Distance (S) = 100 m

Time (t) = 5 s

Speed (v) = ?

We know:

$$v = \frac{S}{t}$$

$$v = \frac{100\ m}{5\ s}$$

$$= 20\ m\ s^{-1}$$

Problem 8.7

A boy runs for 20 seconds with a uniform speed of 5m/s. Find the distance he covers?

Solution

Speed (v) = $5\ m\ s^{-1}$

Time (t) = 20 s

Distance (S) = ?

We know:

$S = v \times t$

$S = 5\ m\ s^{-1} \times 20\ s = 100\ m$

$S = 100\ m$

Problem 8.8

A train took 12 minutes to travel 10 km from station **A** to **B** and 24 minutes to travel 20 km from station **B** to **C**. Calculate the average speed of train in km/hr.

Solution

Total distance = 10 km + 20 km = 30 km

Total time = 12 min + 24 min = 36 min

Time in hours $= \frac{36}{60} = 0.6$ hr

Average speed = ?

We know:

$$v = \frac{S}{t}$$

$$v = \frac{30\ km}{0.6\ hr} = 50\ km\ hr^{-1}$$

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Problem 8.9

The distance of the Earth from the Sun is 149,000,000 km. The speed of light is 300,000 km/s. What is the time taken for light to travel from the Sun to the Earth?

Solution

Distance (S) = 149,000,000 km

Speed (v) = 300,000 km s^{-1}

Time (t) = ?

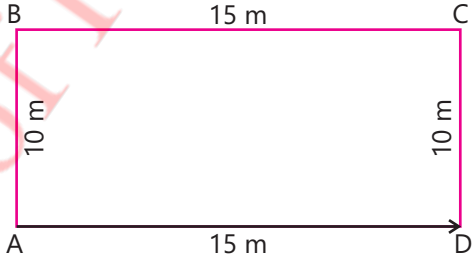
We know:

$$t = \frac{S}{v}$$

$$t = \frac{149000000 \text{ km}}{300000 \text{ km s}^{-1}} = 496.7 \text{ s} = 8 \text{ min } 16.7 \text{ s}$$

8.3.3 Distance and Displacement

Suppose a man travels 10 m from point **A** to **B**, 15 m from **B** to **C** and finally 10 m from point **C** to **D**. In this way he covers a distance of 35 m.



Distance = AB + BC + CD

Distance = 10 m + 15 m + 10 m = 35 m

Displacement is defined as the shortest distance between two points.

In above example, 35 m is the distance a man travels from initial point **A** to final point **D** via **B** and **C**; but it is not the shortest distance between initial and final points (**A** and **D**).

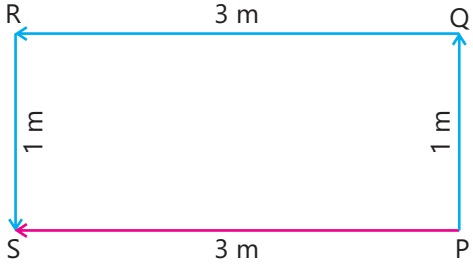
The shortest distance from point **A** to **D** is 15 m which is represented by the line **AD**.

Thus, the distance = 35 m

and displacement = 15 m

Problem 8.10

An object moves from point **P** to **S** along a rectangular path **PQRS** as shown in the Figure. Find:



(i) Total distance covered.

(ii) Displacement from **P** to **S**.

Solution:

(i) Total distance = PQ + QR + RS

= 1 m + 3 m + 1 m = 5 m

(ii) To find the displacement we join P to S by a straight line, hence

Displacement = PS

= 3 m

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8.3.4 Distance, Time Graph

The relationship between two variable quantities (e.g., distance and time) can be shown with the help of a graph.

Activity 8.2

Teacher Guide

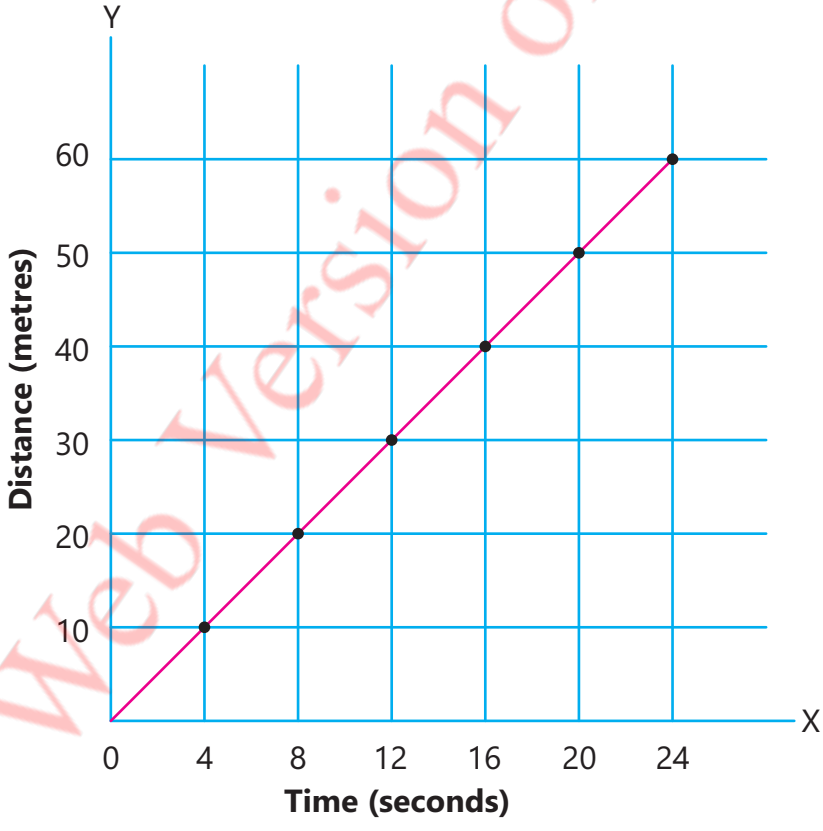
Facilitate students:

- Understand and show the relationship between distance and time with the help of a graph as under:

Suppose a person travels continuously and covers the distance 10 m in 4 s, 20 m in 8 s, 30 m in 12 s, 40 m in 16 s, 50 m in 20 s and 60 m in 24 s.

Distance (m)	0	10	20	30	40	50	60
Time (s)	0	4	8	12	16	20	24

If the distances covered are shown vertically on Y-axis and the time intervals taken for covering the said distances are shown horizontally on X-axis, The distance-time relation can be represented with the help of a graph as under:



This graphs shows that:

1. The person took 4 seconds to go from each marker post to the next and so its speed was constant.
2. The distance travelled is 2.5 metre every second (= 10m/4s) and so its speed is 2.5 m/s.

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8.4 CONTACT AND NON-CONTACT FORCES

Forces can broadly be categorized as:

- Contact forces
- Non-contact forces

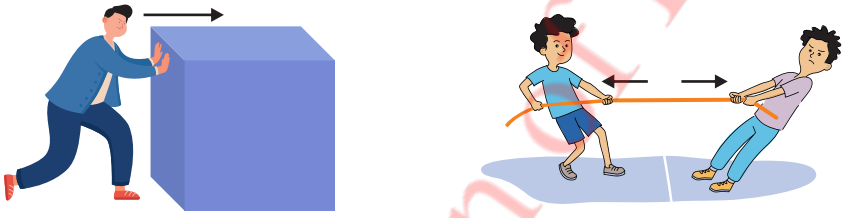
8.4.1 Contact Forces

Contact forces are those forces that act only when objects are in physical contact with other objects and bring about necessary changes.

Examples of contact forces

1. Push and pull

For pushing a box ahead and pulling a rope in opposite directions, we need to make physical contact with them **(Figure 8.4)**.



Pushing a box Pulling a rope

Figure 8.4 Push and pull (contact forces)

For pushing and pulling the objects, the **muscular force** of animals and humans is applied. Muscular force is also an example of contact force **(Figure 8.5)**.

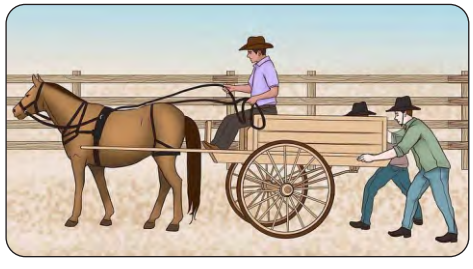


Figure 8.5 Pushing and pulling a cart

2. Frictional force

When a boy stops paddling, the bicycle facing the **frictional force** between its tyres and the ground stops to move **(Figure 8.6)**. The frictional force is produced due to a contact between tyres of bicyle and the ground. The frictional force is therefore a contact force.

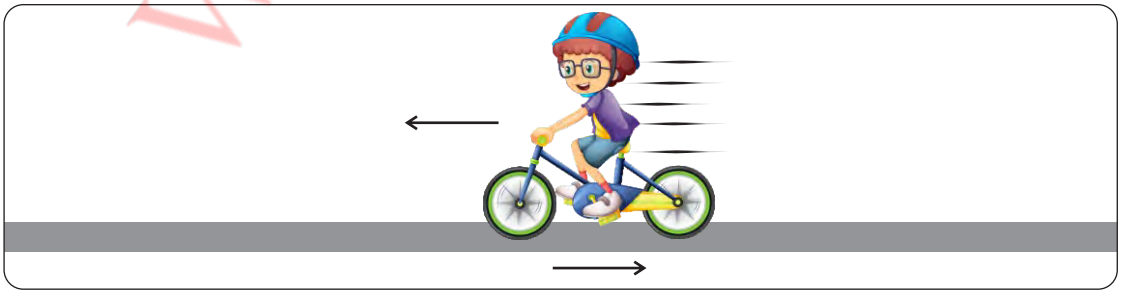


Figure 8.6 Frictional force stops the moving bicycle

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3. Mechanical force

Force is required for lifting heavy objects. Such a force is provided by the machines like cranes. The force exerted by a machine is called **mechanical force**. Machines do not produce force by themselves. They need energy from other sources to produce force. For lifting a heavy object, the object and the carne come in contact with each other. Therefore, the mechanical force that makes the crane lift the object is also a contact force **(Figure 8.7)**.

Figure 8.7 Crane lifting heavy objects

8.4.2 Non-Contact Forces

Some forces do not involve physical contact between the objects on which they act. They act through the space between them. Such forces are called **non-contact forces**.

Example of non-contact forces

Magnetic force **(Figure 8.8)**, electrostatic force **(Figure 8.9)** and gravitational force **(Figure 8.10)** are the examples of non contact forces.

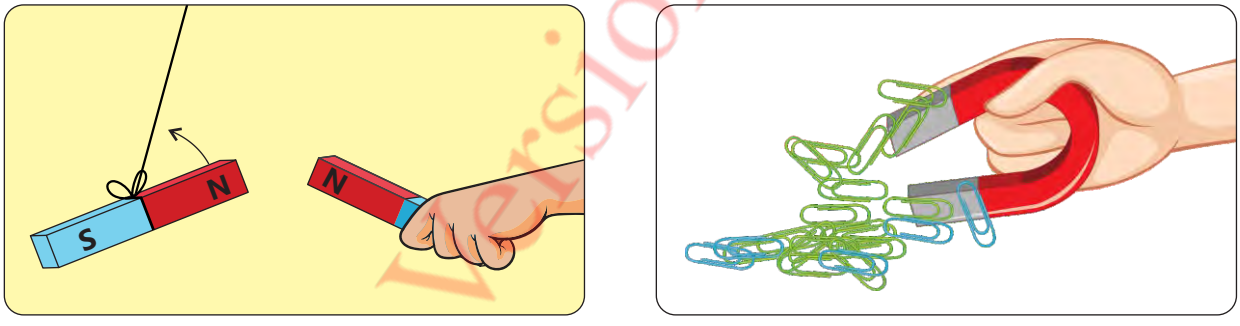

Figure 8.8 Magnetic forces

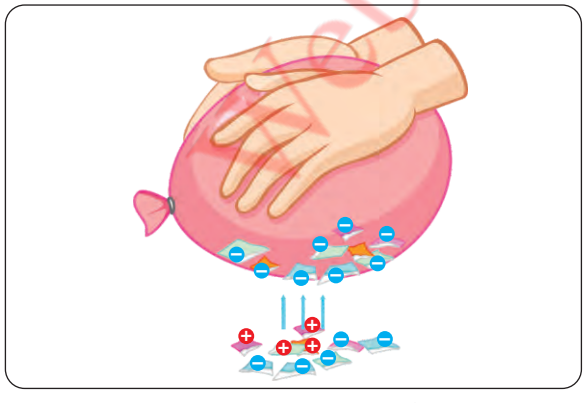

Figure 8.9 Electrostatic force

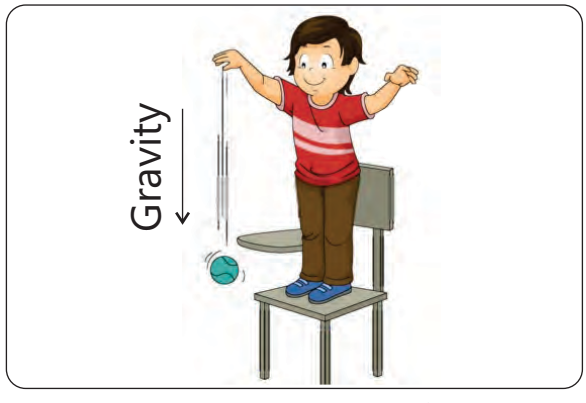

Figure 8.10 Gravitational force

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8.4.3 Action and Reaction Forces

A book placed on a table exerts a force (equal to weight of the book) on the table. This force is called **action**. In response to the action, an equal force is exerted in opposite direction by the table on the book. Such a responding force is called **reaction**. **(Figure 8.11)**.

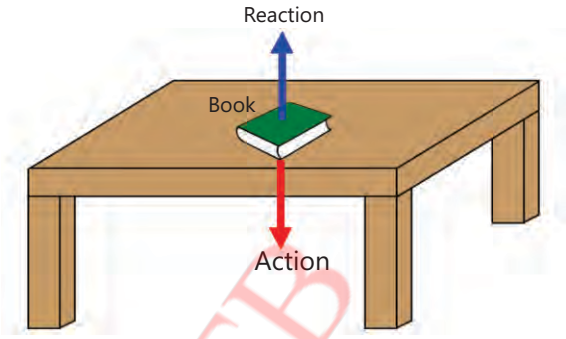

Figure 8.11 Book placed on table

The space shuttle engines push out hot gases as an action force and the hot gases exert a reaction force on the shuttle engine, which makes the shuttle lift up **(Figure 8.12)** .

Figure 8.12 A space shuttle

In both the above mentioned examples, action and reaction are two equal forces, but their directions are opposite. Newton explains this kind of force in a law which is known as the third law of motion This law is stated as:

"To every action, there is an equal and opposite reaction".

KEY POINTS

- Push, pull, gravity, friction, etc., are the examples of the force.
- Force is a physical quantity. The Standard International (SI) unit of force is newton. The symbol used for newton is 'N'.
- Force can change the direction of motion.
- Force is measured by using an instrument called force meter. The force meter is a spring balance, which is of two types; extension spring balance and compression spring balance.
- The shortest distance between two points is called displacement.
- Speed is defined as the distance travelled per unit time
- If an object travels the same distance in the same intervals of time, its speed is called uniform speed.
- If a force is applied on a moving object in the direction of motion, its speed increases.
- If the force is applied in the direction opposite to the direction of motion of the object, its speed decreases.
- If an object travels different distances in the same intervals of time, its speed is called variable speed.

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- The average speed can be calculated by dividing the total distance an object covers by the total time it takes to cover that distance.
- Contact forces are those forces that act only when objects are in physical contact with other objects and bring about necessary changes.
- Some forces do not involve physical contact between the objects on which they act. They act through the space between them. Such forces are called non-contact forces.

QUESTIONS

8.1 Encircle the correct option.

1. An example of contact force:

a. electrostatic force b. muscular force
c. magnetic force d. gravity

2. The force between two negatively charged particles is:

a. gravitational b. frictional c. repulsion d. attraction

3. Which statement is true?

a. for every action force, there is a smaller reaction force in the opposite direction
b. for every action force, there is a smaller reaction force in the same direction
c. for every action force, there is an equivalent reaction force in opposite direction
d. for every action force, there is an equivalent reaction force in the same direction

4. The Earth's pull on the objects is called:

a. gravity b. frictional force
c. electrostatic force d. magnetic force

5. A batsman hits the ball back towards the bowler, which effect of force is seen:

a. change of shape b. change of direction
c. change of state from motion to rest d. change of state form rest to motion

6. Which one of the following statements is correct?

a. 1 m = 1000 km b. m/s is the unit of displacement
c. N is the unit of force d. 1hr = 60 s

7. Which one of the following statements is not correct?

a. Displacement is the shortest distance between two points.
b. Displacement is the distance covered in one second.
c. Metre (m) is the unit of displacement.
d. Rate of change of distance with time is called speed.

8.2 Define the following:

1. Contact forces. 2. Non-contact forces. 3. Gravitational force
4. Displacement 5. Speed

8.3 Constructed Response Questions

1. A rocket has been fired upward to launch a satellite in its orbit. Name the two forces acting on the rocket immediately after leaving the launching pad.

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2. Briefly describe the effect of non-contact force on each of the following:

a. Falling of apple from the tree b. A foot ball that is kicked

c. Iron pins are attracted towards a magnet

d. A porter carrying a load

e. Charged comb attracts small pieces of paper

f. Bringing like poles of two magnets near each other

3. The detail of a 12 hours journey of a car with an average speed of 60 km/hr is given below:

Duration	Distance covered
0 – 2 hours	X
2 – 6 hours	240 km
6 – 12 hours	240 km

What is the value of X?

8.4 Investigate:

1. The readings obtained during an experiment in which a toy train runs down a slope.

Time in seconds	0	2	4	6	8	10
Distance of train in metres	0	10	20	30	40	50

a. Use the data in the Table to plot a graph of distance on Y-axis against time on X-axis.

b. State what the graph tells you about the motion of the toy train:

(i) During the first second

(ii) From 2 to 4 seconds

(iii) From 8 to 10 seconds

8.5 Project:

1. Make a track 30 m long and 50 cm wide.
2. Walk fast along this track. Ask your friend to note the time taken by you for covering the distance 30 m.
3. Repeat the above activity at least three times. Record your findings in a Table as shown below:

S.No.	Duration	Average time taken
1.		_____ seconds
2.		
3.		

Distance travelled = 30 m

Average speed = Distance/time = _____ m/s.

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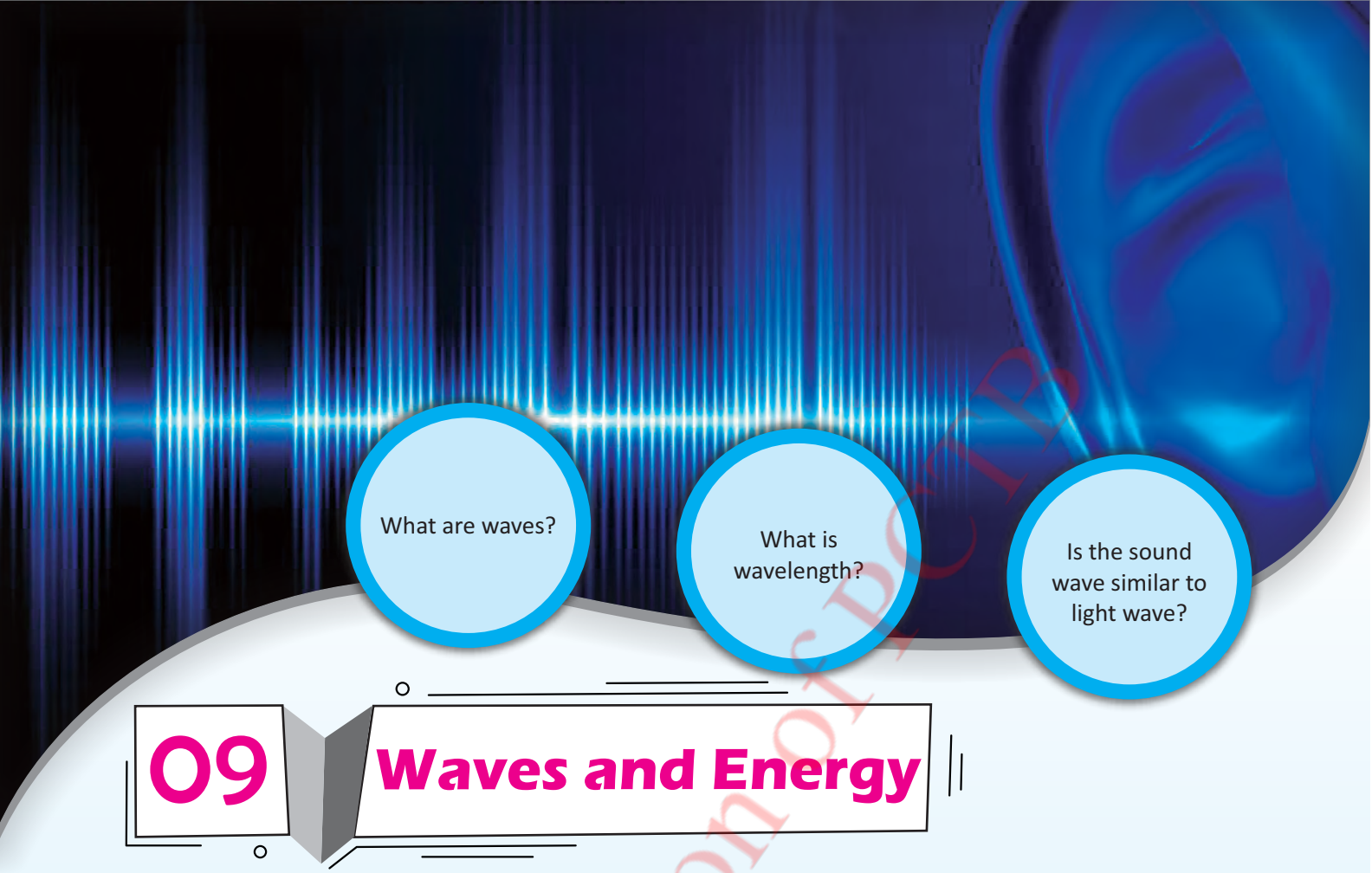

09 Waves and Energy

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Students' Learning Outcomes

After studying this chapter, students will be able to:

- Define a wave.
- Compare the types of waves (mechanical and electromagnetic) with daily life examples.
- Distinguish between Longitudinal and Transverse waves.
- Identify; water wave and Sound wave as mechanical wave; light wave as electromagnetic wave.
- Define the terms: Wavelength, frequency, and time period of wave.
- Define and relate: Pitch and frequency. Amplitude and frequency.
- Explain the factors affecting pitch and loudness of sound.
- Compare and interpret waveforms in terms of pitch and loudness.
- Construct the inverse relation between time period and frequency
- Relate common phenomenon (e.g., echo, hearing thunder after seeing lightning) to the properties of sound.

VOCABULARY

Mechanical waves	Electromagnetic waves	Wavelength	Frequency	Time period
Waves which require material medium to travel through	Waves which don't require any material medium to travel through	Distance between the peaks of two consecutive crests or troughs in a wave	Number of cycles or waves of a vibrating object passing through a point in one second	The time during which an object completes one wave cycle

Recall what you have learnt

- Sound is a form of energy
- Vibrating objects produce sound **(Figure 9.1)**

Figure 9.1 Musical instruments

- Sound needs material medium to travel through
- Noise pollution

Activity 9.1 Assessment

Write **'C'** against the correct and **'I'** against the incorrect statement in the middle column. Also correct the incorrect statement and write it in the next column.

Correct/Incorrect	C/I	Correct Statement
Speed of sound in air is 340 m s^{-1}		
Speed of sound in water is 1,500 m s^{-1}		
Speed of sound in iron is 5,000 m s^{-1}		
Sound can travel through vacuum.		

In this chapter we will learn about:

- Waves
- Mechanical waves
- Electromagnetic waves

9.1 WAVES

If we drop a pebble in the still water in a pond, water is disturbed and ripples are produced on its surface, we call them waves. These waves spread out in all directions from the place where the pebble hits **(Figure 9.2)** and water particles begin to move up and down. Waves are very important for us. They transport energy from one place to another without transporting matter.

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What happens when we clap? Clapping makes the air particles vibrate to produce sound waves **(Figure 9.3)**.

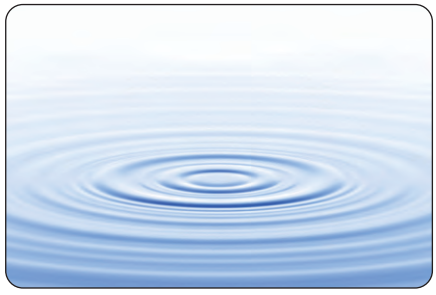

Figure 9.2 Waves on water surface

Figure 9.3 Clapping produces sound

Waves are of two types:

- Mechanical waves
- Electromagnetic waves

Mechanical waves require material medium (solid, liquid, gas) to travel through. Sound waves are the examples of mechanical waves. Electromagnetic waves don't require any material medium to travel through. Light waves are the examples of electromagnetic waves.

9.2 MECHANICAL WAVES

Transverse waves and longitudinal waves are the examples of mechanical waves.

9.2.1 Transverse Waves

The wave in which particles of the medium vibrate perpendicular to the direction of waves is called **transverse wave**.

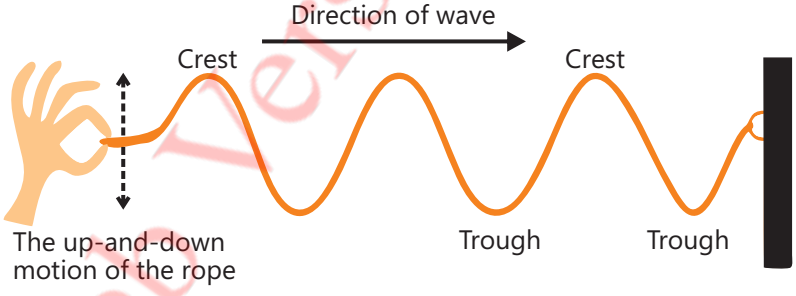

Figure 9.4 Transverse wave

Transverse waves are produced in a stretched string as shown above **(Figure 9.4)**. These waves travel in the form of crests and troughs. The highest point of a wave is called the **crest**. The lowest point of a wave is the **trough**. A complete wave cycle will have both crest and trough. Transverse waves can only be produced in solids or on the surface of a liquid.

Activity 9.2

Take a long spiral spring also called slinky spring. Fix its one end at a rigid support as shown in Figure (a). Shake the other end up and down. What do you observe? As a disturbance passes along the spring, its coils start moving up and down. The disturbances that appear in the forms of waves are called transverse waves. Transverse waves can

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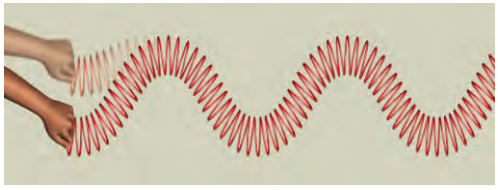
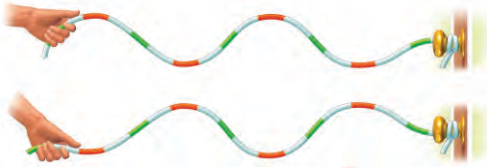
also be observed in a rope by vibrating its one end as shown in Figure (b).



(a)



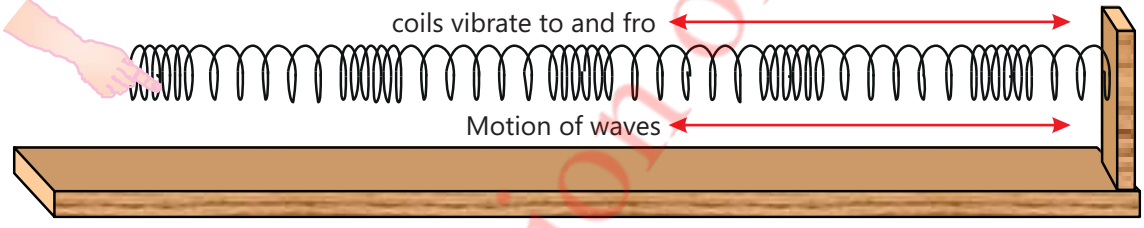
(b)

9.2.2 Longitudinal Waves

The waves in which particles of the medium vibrate parallel to the direction of motion of the waves are called longitudinal waves.

Activity 9.3

Place a slinky spring on a table. Fix its one end at a rigid support (Figure). Push and pull its free end periodically with quick successions. A part of the spring will be compressed with a sudden push. The compression will move to



adjacent part of the spring when the compressed part of the spring returns to its original state: Where as sudden pull elongates a part of the spring causing a rarefaction. This rarefaction follows the compression. As a result, coils of the slinky spring start moving forward and backward. A chain of compressions and rarefactions appear to move from free end to fix end along the spring. In this case, the particles of the medium vibrate parallel to the direction in which waves travel.

Sound waves are also longitudinal waves which can be demonstrated by the following activity.

Activity 9.4

Fix a lit candle in front of vibrating cone of a loud speaker as shown in the Figure. The vibrating cone of loudspeaker produces sound. You will see that the flame of the candle flicks back and forth due to the sound produced by the loud speaker. It can be concluded that in sound waves, the particles of air vibrate back and forth. However, the sound waves travel in the forward direction.

Sound as a compressional wave

Sound wave is an example of longitudinal wave. When someone beats a drum sound is produced by the drum due to vibrations of its diaphragm. The rapid movement of the diaphragm produces disturbances in the air. These disturbances spread out in all direction. When the diaphragm moves

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outward from its normal position, it pushes the nearby air particles. This creates a high density region (high pressure zone) called **compression** as shown in **Figure 9.5**.

When the diaphragm moves inward from its normal position, the air particles relax and spread out. This creates a region of low density (low pressure zone). This is called **rarefaction**. As the diaphragm continues to vibrate, a series of alternate compressions and rarefactions move out in the direction of sound waves.

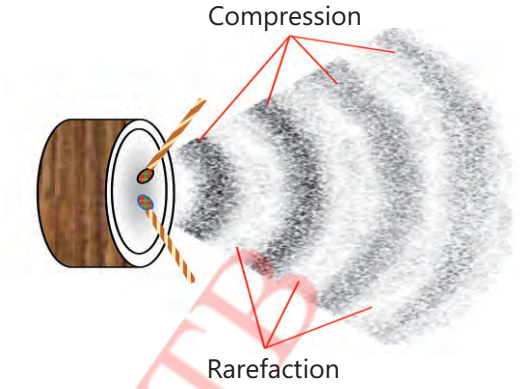

Figure 9.5 Sound waves contain a series of alternate compressions

Do you know?

Sound waves are pressure waves. Greater is the difference in pressure between successive compression and rarefaction louder is the sound.

9.3 BASIC TERMS RELATED TO WAVES

To study waves, we come across various terms e.g., amplitude, wavelength, frequency, and time period. **Figure 9.6** shows a graph for sound pressure verses time. Sound pressure swings about normal (atmospheric pressure) in a region as rarefaction follows compression. Sound pressure has its highest value at the middle of a compression and lowest value at the middle of a rarefaction.

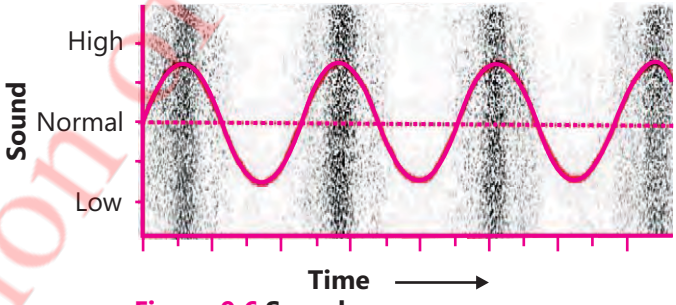

Figure 9.6 Sound pressure verses time graph for sound waves

Amplitude

The maximum displacement of the vibrating objects from its mean position is called its **amplitude (Figure 9.7)**. It is measured in the unit 'metre (m)'. For the wave with larger amplitude, the sound will be louder.

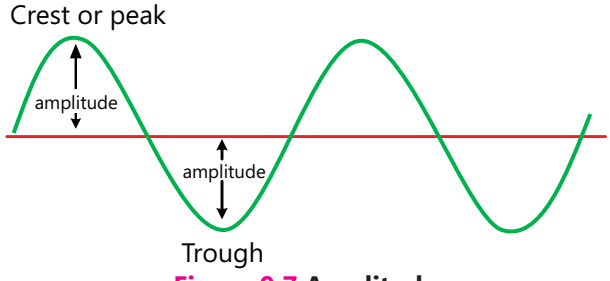

Figure 9.7 Amplitude

Wavelength

Wavelength is the distance between the centres of the compressions or rarefactions of two consecutive waves. In **Figure 9.8**, point **B** and **F** are the centres of two adjacent compressions. The distance between **B** and **F** is equal to wavelength of the wave. The wavelength of a wave is measured in metre (m). It is represented by the symbol **λ** (pronounced as Lambda). Similarly, point **D** and **H**

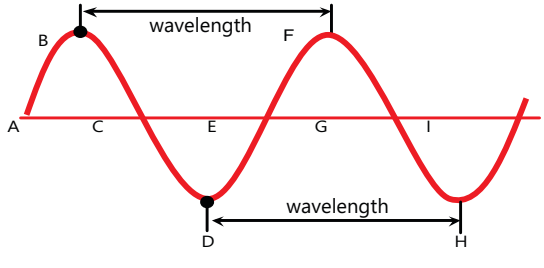

Figure 9.8 Wavelength

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are the centres of two adjacent rarefactions. Thus the distance between **D** and **H** is also equal to the wavelength **λ** of the wave. It is to be noted that the distances between the points **A** and **E** as well as **C** and **G** are also equal the wavelength of the wave.

Frequency

Frequency is the number of waves produced in one second. It is equal to the number of times a body vibrates in one second. Frequency of a wave is represented by the letter **'f'**. Unit of frequency is cycle per second **(c/s)** also called **hertz (Hz)**. For example; if a body vibrates 4 times in one second, its frequency is 4 Hz. The frequency of drum band is 30 Hz means that the diaphragm of the drum is vibrating 30 times in one second. Low, medium and high frequency waves are shown in **Figure 9.9**.

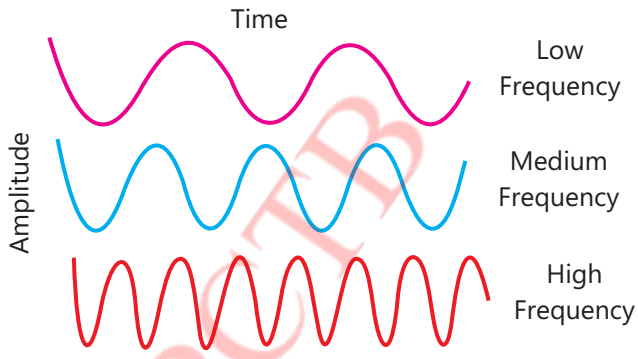

Figure 9.9 Waves of different frequencies

Activity 9.5

- Take a large tub filled with water and a pencil. Move tip of the pencil up and down in water near the edge of the tub. Circular ripples will appear on the surface of water.
- What happens if you increase or decrease the rate of dipping the pencil in water?
- Does the distance between waves vary with the rate of dipping the pencil in water?
- What happens If you increase the force of dipping the pencil?

It is observed that wavelength of a wave goes on decreasing with the increase in the frequency of the wave. Thus, wavelength is inversely proportional to the frequency of a wave.

$$\lambda \propto \frac{1}{f} \quad \text{or} \quad f\lambda = \text{constant}$$

Time period

The time during which a body completes one wave cycle is called the **time period**. It is represented by **T**.

9.3.1 Relationship between Frequency and Time Period

In terms of time period, a wave is measured as to how long it takes to complete a cycle whereas in terms of frequency a wave is measured as how many cycles it completes in a particular period time.

If in time period **T**, the number of vibration is one, then the mathematical relationship between frequency and time period is:

$$f = \frac{1}{T}$$

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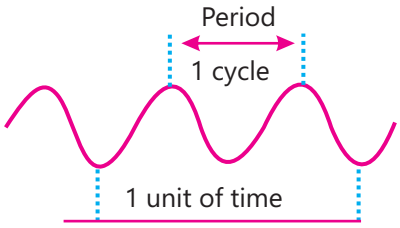
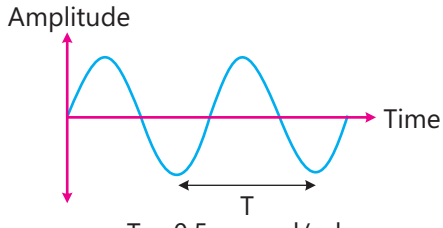


Number of cycles = frequency



T = 0.5 second/cylce

For example; In the Figure above, a rope wave completed two cycles in one second. Its frequency is two cycles per second. If the frequency is two cycles per second, the time of one cycle will be half a second. Mathematically, it can be written as:

$$T = \frac{1}{F} = \frac{1}{2} = 0.5 \text{ second}$$

It shows that the frequency of a wave and time period is inversely proportional to each other.

Problem 9.1: An object produces a sound with a frequency of 50 Hz. Find its time period.

Solution: Time period $= \frac{1}{\text{Frequency}} = \frac{1}{50} = 0.02$ second

Problem 9.2: A pendulum oscillates 50 times in 5 seconds. Find its time period and frequency.

Solution: No. of cycles 'N' = 50
Total time take 't' = 5 s

Step 1: Calculating the frequency

The frequency of a wave is the number of cycles per unit time.

$$f = \frac{N}{t} = \frac{50}{5} = 10 \text{ Hz}$$

Step 2: Calculating the time period

$$\text{Time period} = \frac{1}{\text{Frequency}} = \frac{1}{10} = 0.1 \text{ second}$$

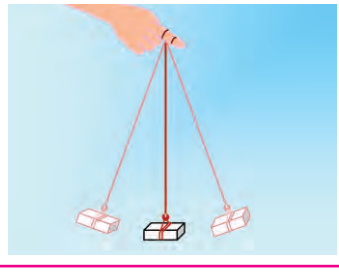
So, the time period is 0.1 second and frequency is 10 Hz.

Audible frequency range

All the day long you hear different sounds. Sound is produced when a body vibrates. Can you hear all the sounds produced by various vibrating bodies? You may think so, but it is not true. We cannot hear all the sounds produced by vibrating bodies. Our hearing range is limited. The sounds that we can hear are called audible sounds.

Activity 9.6

- Take a string of nearly 25 cm long. Tie your eraser at its one end. Hold it from its other end and allow the eraser to move to and fro like a pendulum. Count the vibrations made by the eraser in one minute (60 seconds).
  1. What is the frequency of the vibrating eraser?
  2. Do you hear the sound produced by the vibrating eraser?
  3. Why you do not hear sound of the vibrating eraser?



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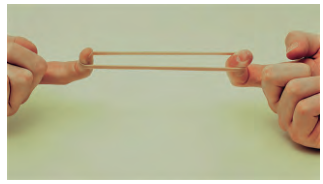
- Stretch a rubber band. Pluck it at its middle.
  1. Can you count the vibrations set up in a rubber band in 1 second?
  2. Do you hear the sound produced by the vibrating rubber band?



Do you know?

Infrasonic waves are those inaudible sound waves that have frequencies below 20 Hz. Ultrasonic waves are those inaudible sound waves that have frequencies above 20 kHz.

Human ear cannot hear sound of a body that is vibrating with a frequency less than 20 Hz. It also cannot hear sound of a body that is vibrating with a frequency more than 20,000 Hz (20 kHz). Thus, audible range of frequencies for humans is between 20 Hz to 20,000 Hz. Audible frequency range is different for different animals **(Table 9.1)**.

Table 9.1 Audiblefrequency range of various animals

Receiver	Frequency range
Dog	40 Hz – 50 kHz
Cat	45 Hz – 65 kHz
Cow	23 Hz – 35 kHz
Rabbit	360 Hz – 42 kHz
Mouse	1000 Hz – 91 kHz
Bat	2000 Hz – 120 kHz
Elephant	16 Hz – 12 kHz
Gold Fish	20 Hz – 3 kHz
Dolphin	2000 Hz – 150 kHz
Owl	200 Hz – 12 kHz

9.4 CHARACTERISTICS OF SOUND

Think of various sounds you hear everyday. What makes them different from one another? Complete the Table given below.

Name Sound	Weak	Loud	Grave	Shrill
lion		✓	✓	
Sparrow	✓			✓
Bell				
Drum				
Cow				
Crow				
Horn				
Whistle				

Figure 9.10 Striking hammer on a metal plate produces loud and shrill sound.

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9.4.1 Pitch of Sound

The characteristic of sound by which a shrill sound can be distinguished from a grave one is called the pitch of the sound.

Note the difference in the sounds of a drum and a bell. The sound of a bell is shrill while sound of a drum is grave. Let us perform an activity to understand it.

Figure 9.11 A drum and a bell

Activity 9.7

- Take a bicycle and keep it on its stand. Paddle the bicycle slowly. Hold a piece of card. Insert other end of the card into the moving spokes of the rear wheel. The spokes of the rotating wheel makes the card vibrate. The vibrating card produces sound. Gradually increase the speed of the wheel by paddling more rapidly. Observe the change in the sound of the card.
  1. Can you estimate the frequency of the vibrating card when the wheel was rotating slowly?
  2. How does the sound change on increasing the speed of the wheel?
  3. What change do you notice in the sound other than loudness?
  4. How does the frequency of vibrating card vary with the speed of the wheel?
  5. How do you relate pitch of sound with the frequency?

Sound of varying pitch is produced by pushing a card into the spokes of a rotating bicycle wheel.

We can conclude from the above activity that an object produces grave sound of low pitch when vibrating with low frequency. The pitch of sound increases with the increase in the frequency of vibration. A shrill sound has a high pitch while a grave sound has a low pitch.

Informative

Each spoke passing before the card causes it to vibrate. Let the wheel has 40 spokes. When the wheel rotates once in one second then 40 × 1 = 40 spokes pass before the card in one second. Hence, the card vibrates 40 time in one second. Thus, the card produces a sound of frequency 40 Hz. When the wheel completes five rounds in one second then 40 × 5 = 200 spokes pass before the card in one second. Hence, the card vibrates 200 times in one second. In this case, the card produces a sound of frequency 200 Hz.

A drum produces a grave sound of low pitch. It is because its diaphragm vibrates with a low frequency. A bell produces shrill sound. A shrill sound of it is because a bell vibrates with a high frequency.

Voices of children are of high pitch as compared to elders. Voices of men are of low pitch as compared to women. Voices of birds are of high pitch than animals.

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9.4.2 Loudness of Sound

Another important property of sound is its loudness. What do you do to make a louder sound?

Activity 9.8

- Strike a drum gently. Note the sound produced by it. Again, strike the drum bit strongly. Note the sound produced by it. Go on striking the drum repeatedly with increasing force. Note the sound produced by it and the amplitude of the vibrating diaphragm in each case.
  1. Does the loudness of sound depend on the size and shape of the vibrating body?
  2. Does the loudness of sound depend on the amplitude of the vibrating body?
  3. Does the amplitude of vibration depend on the force hitting the body?
  4. What do you conclude from this activity?

Loudness of sound from a drum depends on the amplitude of its vibrating diaphragm.

PROJECT (Design a musical instrument)

Take six nails, three thin wires and a piece of wood about half inch thick, 20 inches long and 3 inches wide. Fix three nails on one of its smallest sides. Fix three nails on the top of wooden piece. Stretch thin wires between each set of nails as shown in **Figure 9.12**. Put a pencil under these wires. Move the pencil towards the edge to tighten the wires. Hold a coin with your fingers. Slide its edge on these wires one by one and listen their sounds.

Figure 9.12
Designing a musical instrument

- Do sounds produce by the wires have same pitch?
- Does length of a wire affect the pitch of sound?
- Can you vary the pitch of sounds produced by these wires?
- What happens to the sound when you loosen or tighten a wire?
- Can you play it as a musical instrument?

9.4.3 Echo

Echo is a sound that is repeated because the sound waves are reflected back. Sound waves can bounce off smooth, hard objects in the same way as a rubber ball bounces off a wall. Although the direction of the sound changes, the echo sounds the same as the original sound, as shown in the **Figure 9.13**.

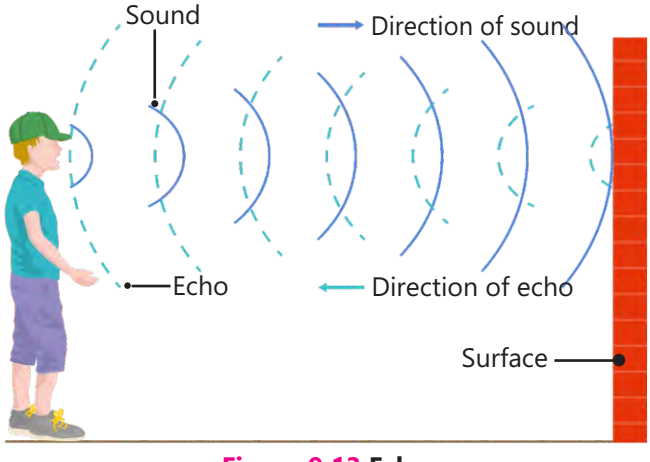

Figure 9.13 Echo

Echo is heard clearly when reflecting surface is at least 17 metres away. Echoes can be heard in

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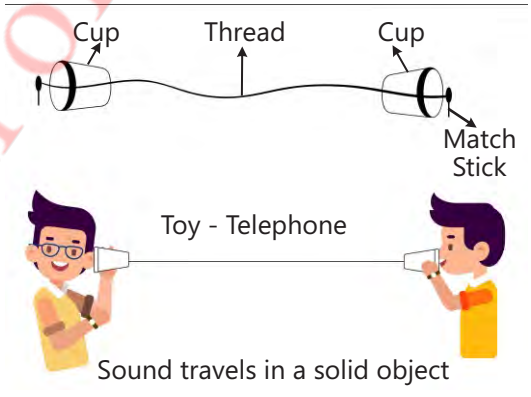
small spaces with hard objects like walls. That is why echoes can be heard in a canyon, cave, or mountain range. Sounds are not always reflected. If they meet a soft surface, such as a cushion, they will be absorbed and will not bounce back.

Do you know?

- Louder sounds are considered harmful for human ears.
- Dolphins can hear sounds underwater from up to 25 km away.
- Sound can travel about 4 times faster in water than in air.
- Sounds are characterized from their loudness, pitch and quality.
- If some explosion takes place on the Sun, the sound of the explosion will not reach the Earth, because there is a vacuum between Earth and the Sun.

Activity 9.9

- Take two tin cans, use them to make a toy telephone in which vibrations travel along with a stretched cord.
- Make one hole in the bottom of each tin can.
- Connect the two cans through a fine reel thread or thin metal wire as shown in the Figure.
- Keep the thread stretched and talk into the can. It will make bottom of the can vibrate.
- The vibrations so produced travel along with the wire and make the bottom of the other can vibrate.



Thunder sound reaches the ground after lightning

Lightning and thunder take place in the sky at the same time due to the release of energy. Thunder is a sound wave whereas, lightning is the emission of electromagnetic energy. Lightning is seen earlier and thunder is heard later. It is because, light travels faster than sound. Hence, you see lightning immediately, but it takes the sound of thunder a few seconds to reach you **(Figure 9.14)**.

Figure 9.14 Lightning and thunder

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Relationship of amplitude and frequency

Amplitude tells us how much energy is there with the wave. A high amplitude wave is a high- energy wave, and a low-amplitude wave is a low- energy wave.
In case of sound waves; a high amplitude sound will be loud, and a low amplitude sound will be quiet. In case of light waves, a high amplitude beam of light will be bright, and a low amplitude beam of light will be dim **(Figure 9.15)**.

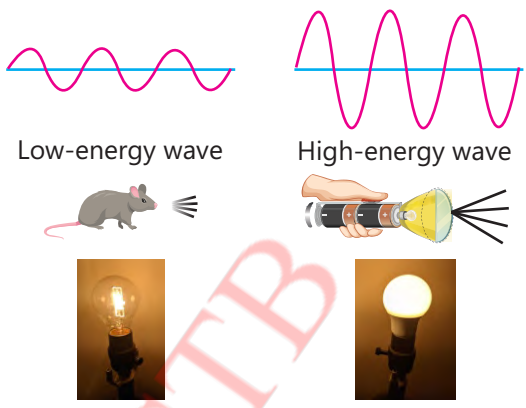

Figure 9.15 Dim and bright lights

Amplitude is not the only factor that affects the energy of a wave. The other factor is frequency. A wave of a particular amplitude will transmit more energy per second if it has a higher frequency, because more waves are passing by in a given period of time. Thus, amplitude and frequency are the two factors that affect the energy transferred by a wave.

9.5 ELECTROMAGNETIC WAVE

Electromagnetic waves or EM waves are the waves that are created as a result of vibrations between an electric field and a magnetic field. A light wave which is visible to our eyes is a part of electromagnetic wave **(Figure 9.16)**.

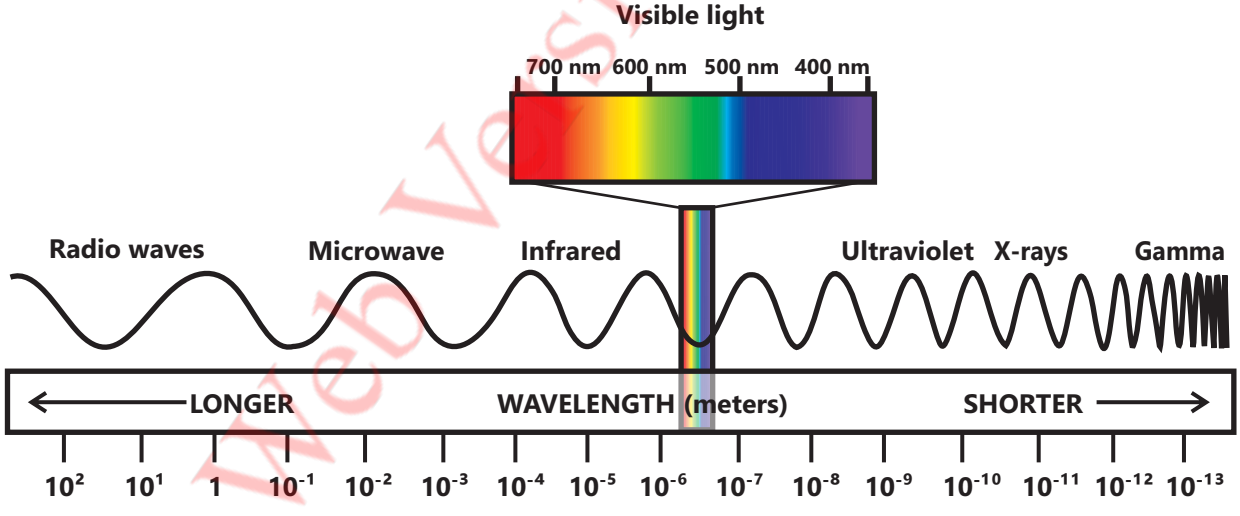

Figure 9.16 Electromagnetic wave

Do you know?

UV, X-rays and Gamma rays are dangerous as they have a small wavelength and high energy. They can damage human body cells causing cancer.

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The human eye can detect only a range of wavelength of electromagnetic wave between 400 - 700 nm (nano metre). This range of wavelength in electromagnetic waves is called **visible light**. Light waves are different from other waves because they can travel in the vacuum. Light wave is categorized according to frequency or wavelength.

When a beam of light from the Sun enters a glass prism, it is split into seven colours **(Figure 9.17)**, i.e., violet, indigo, blue, green, yellow, orange and red. These colours make visible part of the electromagnetic radiation. 400 nm is the wavelength of violet colour, whereas, 700 nm is the wavelength of red colour.

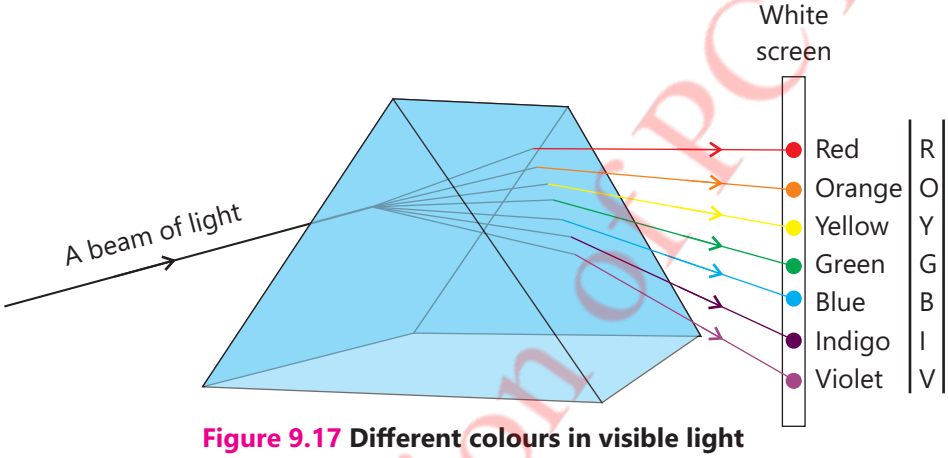


Figure 9.17 Different colours in visible light

Applications of electromagnetic waves:

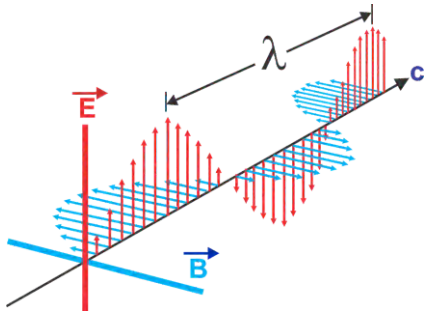
Electromagnetic waves with high frequency or short wavelength include ultraviolet light, X-rays and Gamma rays. Electromagnetic waves with low frequency or longer wavelength include infrared light, microwaves and radio waves. Some of the applications of electromagnetic waves are given below:

- **Radiowave:** communications - radio, telephone and television
- **Microwave:** cooking, as it heats the water or fat in food stuffs in microwave oven.
- **Infra red waves:** short-range communication such as remote contacts
- **Visible:** Illuminates things as we can see them
- **UV:** Sterilization, as it kills bacteria
- **X-rays:** To see through soft tissue and look at the skeleton
- **Gamma rays:** Used to kill cancer cells during gamma rays radiotherapy

Brain teaser

Electromagnetic waves are produced due to electric and magnetic fields. Both fields oscillate perpendicular to each other.

- Conduct an interactive discussion using library and internet resources.



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KEY POINTS

- Waves are the patterns of vibratory motion that transfer energy from one place to another without transferring matter.
- Waves which require material medium to travel through are called mechanical waves.
- Waves which don't require any material medium to travel through are called electromagnetic waves.
- In transverse waves, the vibrations of particles are perpendicular to the direction of waves.
- In longitudinal waves, the vibrations of particles are parallel to the direction of waves.
- Sound wave is a longitudinal wave which travels through the medium.
- Light wave is electromagnetic wave which does not require material medium to travel through.
- Wavelength is the distance between two consecutive compressions or rarefactions.
- Frequency is the number of cycles or waves of a vibrating object passing through a point in one second.
- When sound waves are reflected back from a hard surface, an echo is heard.
- Loudness of sound depends upon amplitude, surface area of vibrating object and distance from the object producing the sound.

QUESTIONS

9.1 Encircle the correct option.

1. Sound waves are not:

a. compressional waves
b. transverse waves
c. mechanical waves
d. low frequency waves

2. Sound cannot pass through:

a. solid
b. liquid
c. gasses
d. vacuum

3. The speed of sound in air is:

a. 100 m/s
b. 340 m/s
c. 1000 m/s
d. 330 km/s

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4. **Which of the following animals can respond to lowest frequency?**

a. cat
b. cow
c. dog
d. elephant

5. **Which of the following animals can respond to highest frequency?**

a. bat
b. cat
c. frog
d. dolphin

6. **Which have audible range for 2 k Hz and 120 k Hz?**

a. human
b. owl
c. bat
d. dolphin

7. **Which of the following features is the height of the wave from the rest position or midline?**

a. frequency
b. amplitude
c. pitch
d. wavelength

8. **Which of the following features of a wave is the number of waves that pass by each second?**

a. loudness
b. amplitude
c. frequency
d. wave speed

9. **What is transferred by the movement of waves?**

a. matter
b. energy
c. nothing
d. both the matter and energy

10. **What type of wave does not need matter to travel through?**

a. mechanical
b. electromagnetic
c. sound
d. transverse

11. **Which sequence of visible colour is correct from longest wavelength to short wavelength?**

a. violet, indigo, blue, green, orange, yellow, red
b. red, orange, yellow, green, blue, indigo, violet
c. red, yellow, green, orange, violet, blue, indigo
d. red, yellow, green, orange, violet, indigo, blue

9.2 Define the following:

1. Wave
2. Electromagnetic wave

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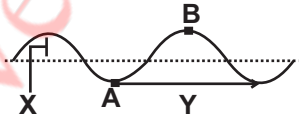
3. Wavelength
4. Frequency
5. Amplitude
6. Time period

9.3 Answer the following questions.

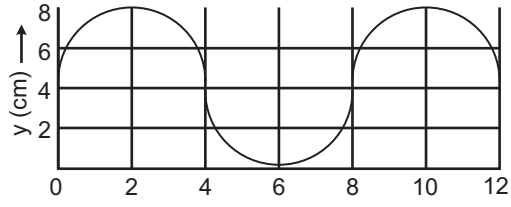
1. How can you differentiate between longitudinal and transverse waves?
2. Why we consider sound waves as longitudinal waves?
3. Give examples of sounds that differ in
   (1) loudness (2) pitch ?
4. What is meant by audible sound?
5. What is the audible frequency range of human?
6. What is the audible frequency range of a bat?
7. Which type of sounds are used in some emergency?

9.4. Constructed Response Questions

1. State some important uses of sounds.
2. How can you prove that animals or birds also communicate with one another?
3. Why we cannot hear the whistle of a bat?
4. Why you can hear very weak sound easily in the night but not during the day?
5. The given wave is transverse in nature.
   Identify and write the names for A, B, X and Y



6. For a transverse wave as shown in the Figure, Answer the following questions:
   a. What is the amplitude of the wave?
   b. What is the wavelength of the wave?



9.5 Investigate:

Snake, fish, frog and locust do not have ears. How do they hear sound?

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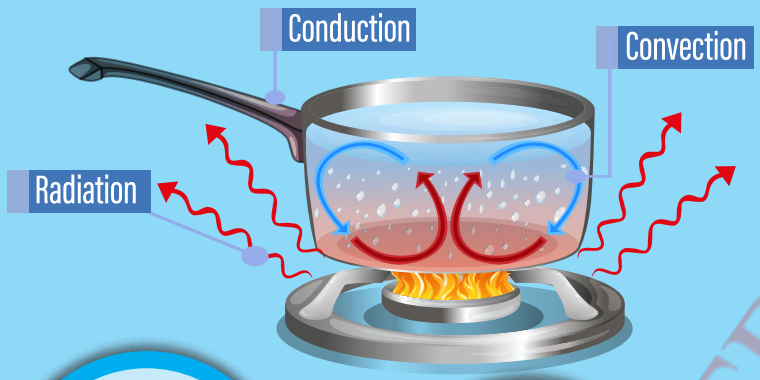

Why do we feel things hot or cold?

Are the heat energy and temperature same?

What is kinetic molecular theory?

10 Heat and Temperature

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Students' Learning Outcomes

After studying this chapter, students will be able to:

- Describe the expansion of the three states of matter on heating, and contraction on cooling, in terms of particles.
- Predict the effects of heat gain and heat loss.
- Compare all three scales of temperature (including inter-conversion of temperature scales).
- Define the terms heat and temperature on the basis of Kinetic Molecular Theory.
- Explain why metals are good thermal conductors and fluids are poor conductors of heat on the basis of particle model.
- Construct the concept of heat conduction, convection and radiation by applying particle theory including daily life examples.
- Identify the effects of thermal expansion and contraction with their applications in daily life.
- State and explain the practical methods of thermal insulation used for constructing buildings.

VOCABULARY

Heat	Temperature	Conduction	Convection	Radiation
The measure of thermal energy of a substance	Degree of hotness or coldness of an object	Flow of heat through a matter from hotter end to the colder end	Transfer of heat from one place to another by actual movement of liquid or gaseous particles	Spreading out of heat directly from the source in the form of rays

What you have learnt

- Heat
- Temperature
- Thermometer

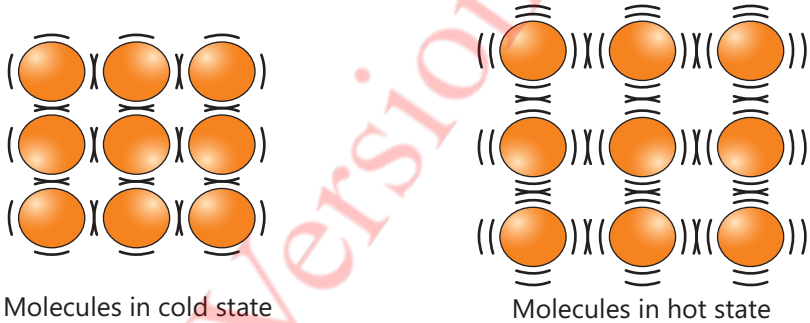
In this chapter we will learn about:

- Heat and temperature
- Modes of heat transfer
- Thermal expansion and contraction
- Thermal insulation in buildings

10.1 HEAT AND TEMPERATURE

Heat is a form of energy. It travels from hot object to cold object. As we have learnt that particles in all the three states of matter are always in a state of motion. The energy due to the motion of particles is called kinetic energy. It is also known as **thermal energy**. Heat is the measure of thermal energy of all the particles of a substance.

We have also learnt that the tiny particles making all the three states of matter are atoms, molecules or ions, etc. Because of constant motion, the atoms and molecules in all the material objects have average kinetic energy. When an object is heated or cooled, the average **kinetic energy** of its atoms, molecules or ions increases or decreases **(Figure 10.1)**.



Molecules in cold state Molecules in hot state

Figure 10.1 Effect of heat on material particles

Heat loss or heat gain

When water or some other object is placed in a freezer, it loses thermal energy (heat loss). As a result, it becomes cold. When some ice cubes taken in a beaker are heated on a burner, the thermal energy of ice increases (heat gain). As a result, it melts.

10.1.1 Temperature

When we touch a steel plate placed in the sunlight on a hot summer day, we feel that it is hot. When we touch the same plate placed outside in a winter night, we feel that it is cold. It is our sense of touch that tells us whether an object is hot or cold.

Activity 10.1

- Put some boiling water in a glass.

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- Place a steel spoon in it.
- Touch the spoon with your finger. Is it hot?
- Wait for a short time and touch the spoon again. Is it hot now?
- After another small interval, touch the spoon again. Is it hotter than before?
- We will observe that the spoon becomes hotter and hotter with the passage of time. We say that the temperature of the spoon is rising.

The degree of hotness or coldness of an object is called its temperature. The hotter is an object, the greater is its temperature. Heat and temperature are closely related. The temperature of an object can be changed by the addition or removal of heat.

10.1.2 Thermometer

The device used to measure temperature of an object is called thermometer.

A thermometer is usually made of a glass tube having a fine bore in it. The tube contains a bulb at its lower end. The bulb is filled with mercury or alcohol (**Figure 10.2)**.

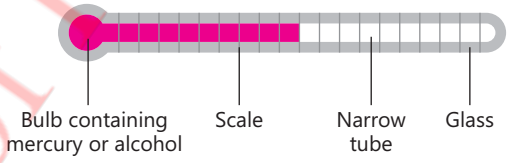

Figure 10.2 Thermometer

When the bulb of a thermometer is made in contact with the hot object, the alcohol/mercury expands and its level rises in the tube. At a cold place, the alcohol/mercury contracts and its level falls down in the tube. The alcohol or mercury level in the glass tube indicates the temperature.

10.1.3 Common Scales of Temperature

Short lines are marked on the thermometer to note the alcohol/mercury level. These are called temperature scales. Two temperature scales are commonly used:

(i) Centigrade or Celsius scale

(ii) Fahrenheit scale

Figure 10.3 shows the two scales on the thermometers. These scales are based on the temperatures of melting of ice and boiling

The temperatures of melting ice and boiling water are two fixed temperatures.

On the Centigrade scale, the interval between two fixed temperatures is divided into 100 equal divisions. Each division is called a centigrade degree (°C). On the Fahrenheit scale, the interval between two fixed temperatures is divided into 180 equal divisions. Each division is called a Fahrenheit degree (°F).

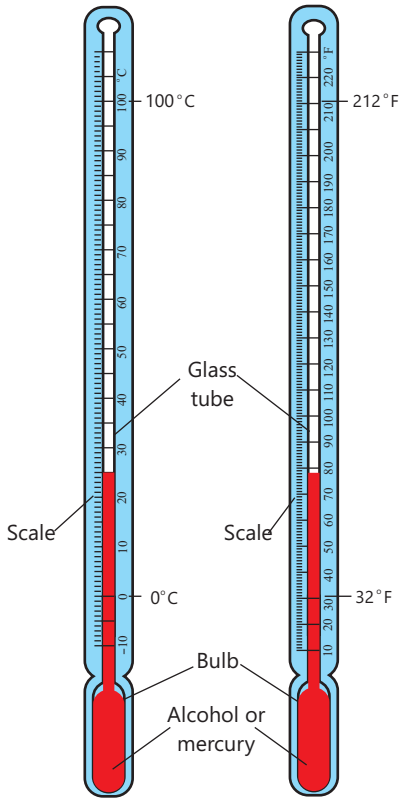

Figure 10.3

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Kelvin or Absolute scale

Kelvin or Absolute scale for measuring temperature is adopted by System International (SI). As reference points, the freezing point of water in Kelvin scale is 273 K and the boiling point of water is 373 K. Interval between these two fixed points is divided into 100 equal intervals. Each interval on the scale is called one Kelvin and denoted by K.

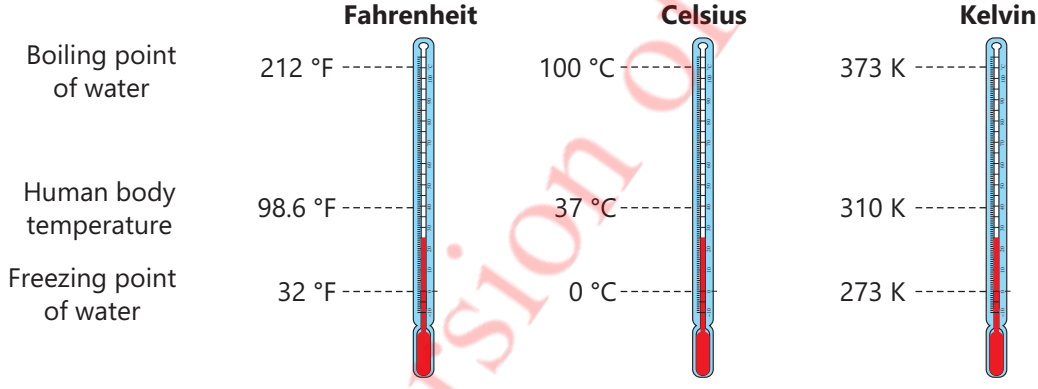
- For converting the temperature given in °C to Kelvins, 273 is added to the given value.
  Temperature in K = Temperature in °C + 273
- For converting the temperature given in Kelvins to °C, 273 is subtracted from the given value.
  Temperature in °C = Temperature in K – 273

Activity 10.2

Teacher Guide

Facilitate students:

- Examine the temperature scales given below.
- How to convert the temperature given in Kelvin scale to Celsius scale.



Formulae for interconversion temperature scales (°C and °F)

Celsius to Fahrenheit	Fahrenheit to Celsius
$°F = \frac{9}{5}(°C + 32)$	$°C = \frac{5}{9}(°F - 32)$

Table 10.1 Comparison of heat and temperature

Heat	Temperature
Heat is the measure of thermal energy of a substance. It is the total kinetic energy of all the particles of a substance.	The degree of hotness or coldness of an object is called its temperature. It is the measure of average kinetic energy of all the particles of a substance.
SI unit of heat is Joule (J).	SI (System International) has adopted Kelvin scale for measuring temperature.
Other unit of heat is Calories (cal).	Other scales are Fahrenheit, Celsius/Centigrade

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10.2 THERMAL EXPANSION AND CONTRACTION

Therm means heat. Thermal expansion is the expansion of material objects on heating. It means that things expand on heating and contract on cooling. In this section, we will get to learn about thermal expansion and contraction of solids, liquids and gases.

10.2.1 Thermal Expansion and Contraction of Solids, Liquids and Gasses

Usually solids expand on heating and contract on cooling. When a solid is heated, its particles gain energy and vibrate more vigorously about their fixed positions forcing each other further apart. As a result, the solid object expands. Similarly, particles in a liquid or gas gain energy on heating and are forced further apart. The degree of expansion depends on the nature of the substance. For a given rise in temperature a liquid will expand more than a solid. Gases expand enormously on heating. They can cause explosions on heating in a confined space.

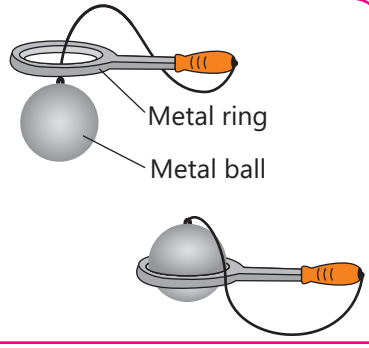
Some solids expand very little such that we may not notice the expansion. Different metals expand or contract at different temperatures and by different amounts. For example, one metre long brass rod increases 1 mm in length when its temperature increases by 100 °C.

Informative

In a fire, the thermal expansion of steel beams, concrete and glass can cause considerable damage.

Activity 10.3 **Thermal Expansion and Contraction of Solids**

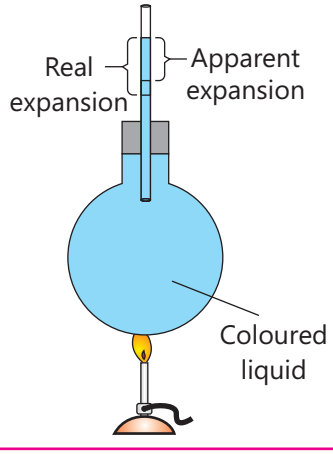
- Take a metal ball and a ring through which the metal ball slips by touching the walls of the ring at room temperature.
- Now heat the metal ball to a high temperature and then try to pass it through the ring.
- What do you observe and why it happens so?
- Let the metal ball be cooled at room temperature and again try to pass through the ring.
- What do you observe now and why it happens so?



10.2.2 Thermal Expansion and Contraction of Liquids

Activity 10.4

- Take a round bottomed flask and fill it fully with coloured water.
- Pass a glass tube which is open at its both ends through a cork or rubber plug and fit into the mouth of the flask tightly as shown in the Figure.
- Note the level of the coloured liquid in the glass tube.
- Now heat the flask over a burner.
- Observe what happens to the level of the coloured water in the glass tube.
- Record what do you observe?
- Do not switch the burner off and wait for noting the next happening to the level of the coloured water in the glass tube.
- Now switch the burner off and let the hot system come back to room temperature.
- Note the level of the liquid again in the glass tube.



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The above activity will let you know that first the level of coloured liquid in the glass tube falls and after some time it rises up. This is because on heating, first the flask expands and its volume or capacity to contain a liquid increases. This makes the level of the colourd water in the glass tube fall. When the flask gets hot, the coloured water filled in it absorbs heat. This makes the liquid expand and its level in the glass tube rises up. It shows that liquids expands on heating. When the system is cooled to room temperature, the level of the water in glass tube falls to its original position. It means, liquids contract on cooling.

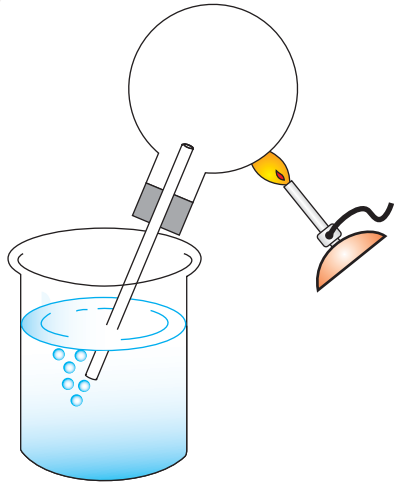
Liquids in drums and pans may overflow when heated. This is due to the fact that liquids expand at a greater rate than solids.

10.2.3 Thermal Expansion and Contraction of Gases

Gases expand on heating and contract on cooling, let us do the following activity.

Activity 10.5

- Take an empty round bottomed flask.
- Pass a glass tube which is open at its both ends through a cork or rubber plug and fit into the mouth of the flask tightly.
- Invert the system and dip the outer end of glass tube in the water taken in a beaker or glass in such a way that the level of water in the glass tube cannot disturb.
- Note the level of water in the glass tube.
- Heat the flask as shown in the Figure.
- We will see that air bubbles come out of the tube.
- Where do bubbles in the water come from?
- Remove the burner and let the flask be cooled.
- Note the level of water in the glass tube again.
- What happens to water level in the glass tube and why?



This activity will make you learn that air in the empty flask expands on heating. As a result, air in the flask expends and air bubbles come out from water. On cooling, the air inside the flask contracts, as result, a suction is created in the flask which pulls the water level in glass tube up.

Do you know?

If air is filled into the car tyres to the fullest. The tyres often burst in the hot afternoon. This is because of expansion of air on getting heat from the surrounding.

10.2.4 Applications of Expansion and Contraction

Riveting

When a hot solid object is cooled, it contracts and strong forces are developed during the process of contraction. These forces are used in riveting the metallic objects together. Hot riveting is a common method to fasten two metal plates firmly. A rivet consists of a smooth cylindrical shaft

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with a head on one end **(Figure 10.4)**. The end opposite to its head is called buck-tail. For joining the two steel plates, they are placed one above the other and holes are drilled in them. The rivets (small steel rods) are made red hot and inserted in the holes of the plates **(Figure 10.5)**. The ends of the rivet are hammered into the hole. This becomes easy because heating of rivets softens them. When the rivets cool, they force plates to come closer and firmly grip them together. This makes the joints water–proof or steam–proof.

Figure 10.4 Solid Rivets

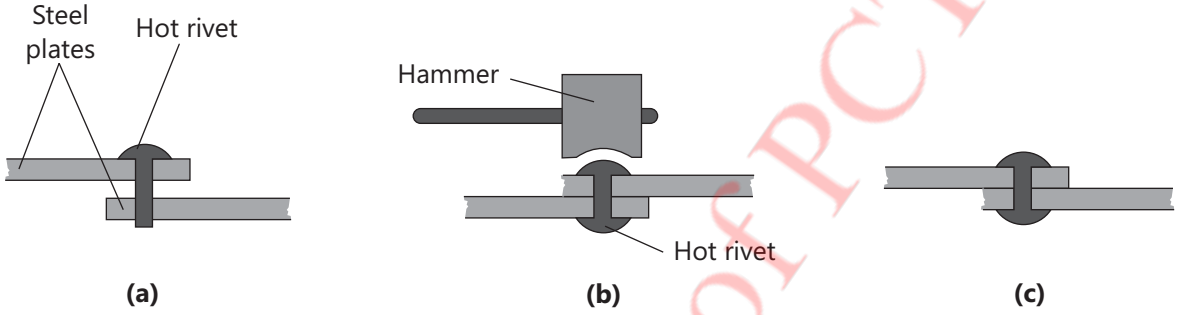

Figure 10.5
(a) hot rivet inserted through holes in two steel strips.
(b) one end on the rivet is hammered flat to form a new rivet head.
(c) when the rivet cools, it contracts and pulls the steel plates tightly.

Fixing a metal tyre over the wheel

The metal tyre which is to fix over the wheel is made smaller in diameter as compared to the wheel. On heating, it expands and its diameter increases. So, it is first heated and then fixed over the wheel. On cooling, the metal tyre contracts and fits over the wheel tightly **(Figure 10.6)**.

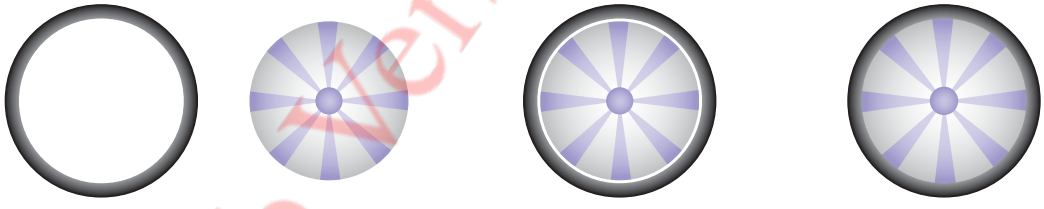

Figure 10.6
(a) The cold metal tyre and wheel.
(b) Expanded metal tyre fixed loosely over the wheel.
(c) On cooling the tyre is firmly fitted over the wheel.

10.2.5 Uses of Expansion and Contraction in Everyday Life

Expansion gaps in concrete road

Concrete in roads and paths expands in the summer because of high temperature. This makes the roads ruptured. To avoid such loss, small gaps are left after every few meters in the concrete roads and paths **(Figure 10.7)**.

Figure 10.7 Gaps in concrete surface of road

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Railway tracks

Railway tracks expand in hot days. If there is no gap, this is very dangerous for trains. Train can derail and endanger passengers.

Figure 10.8 Railway Track

Expansion of bridges

In building bridges, engineers must account for expansion in their design. This is because gaps are left at one end, and that end is supported by rollers **(Figure 10.9)**.

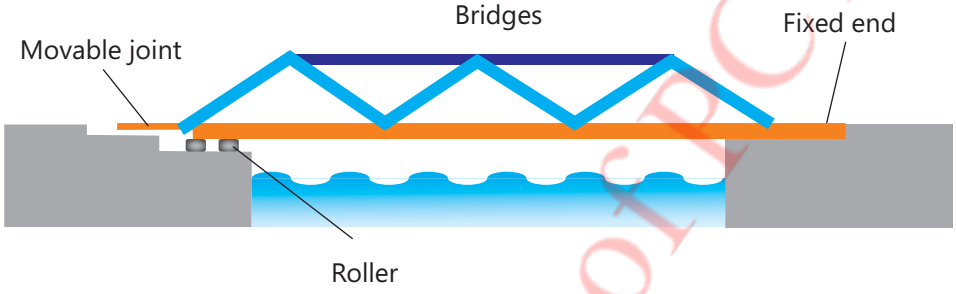

Figure 10.9 Iron bridge

Rollers allow bridge to slide over them smoothly when expanded. Otherwise, large stresses would arise and the concrete would crack.

Overhead power and telephone wires

Overhead cables and telephone wires raised on poles expand during hot summer days. They contract in cold weather and become tight **(Figure 10.10)**. They may even snap. Allowance is made for the expansion or contraction so that the wires do not sag too much during the day or snap at night. To prevent this, they are strung loosely from pole to pole to allow for contraction.

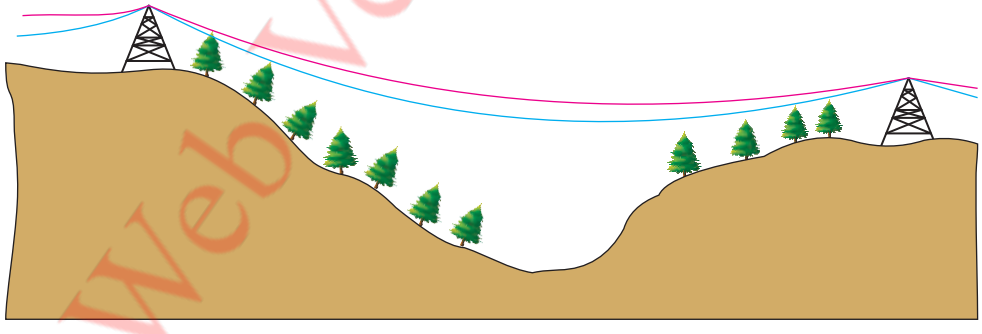

Figure 10.10 Overhead power and telephone wires

Large bends in pipes

Water pipes and pipelines can expand during hot weather and may burst. The bends in pipes allow them to expand or contract without cracking.

Mercury or alcohol in thermometer

Mercury and alcohol are used in thermometers. These liquids expand and rise up in the tube when they get hotter. They contract and fall down in the tube on becoming cold.

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10.3 MODES OF HEAT TRANSFER

10.3.1 Conduction

In solids, atoms or molecules are tightly held together. They vibrate constantly about their mean positions. When one part of a solid object is heated, its atoms or molecules gain heat energy, due to which their vibrations become stronger. They collide with the neighbouring atoms or molecules and cause them to vibrate strongly. In this way, they transfer their heat energy to the neighbouring atoms or molecules and onwards.

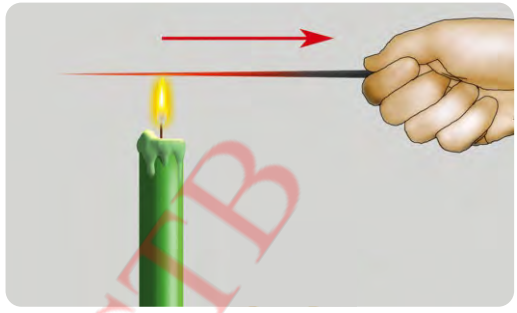

Figure 10.11 Conduction of Heat

The transfer of heat from one part of the solid to its other parts by vibrations and collisions of the particles (atoms or molecules) is called conduction of heat **(Figure 10.11)**.

Good and poor conductors of heat

The material that allow heat to travel through them faster are called **good conductors of heat.** Metals are good conductors of heat. Because, in metals heat is not only conducted by vibrating atoms but also by the free electrons. Iron, copper, silver and aluminium metals are the examples of good conductors of heat.

The materials which do not allow heat to pass through them easily, are called **bad conductors of heat**. Non metals are bad conductors of heat as they do not have free electrons in them. Wood, rubber and glass, etc., are the examples of bad conductors of heat.

Activity 10.6

- Take a cup and fill it with boiling water.
- Dip a metal spoon and a plastic spoon in boiled water.
- After 2-3 minutes, touch the handle of metal spoon. Does it feel hot?
- Now touch the handle of plastic spoon. Does it feel hot?
- You will observe that the metal spoon becomes hot to touch while the plastic spoon remains at room temperature and we can touch it easily.
- What do you conclude from this activity?

10.3.2 Convection

The transfer of heat from one place to another by actual movement of liquid or gaseous particles is called **convection** of heat **(Figure 10.12)**. In this method, molecules of liquid or gasses which are in contact with a hotter part of the container get hot.

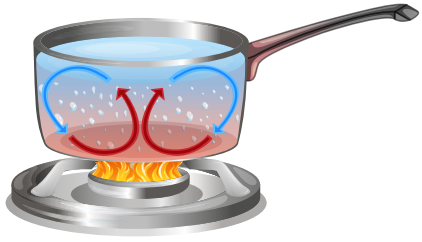

Figure 10.12 Convection of heat

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These hot molecules being lighter, rises up and cold molecules come down to fill the place. In this way, molecules of liquids and gases transfer heat by their actual movement.

10.3.3 Radiation

The third method of heat transfer is **radiation**. In this method, heat spreads out directly from the source in the form of heat rays **(Figure 10.13)**. Radiation process does not require any material medium for heat transfer. Like light, heat rays can pass through transparent material such as air, glass, water, etc. Heat from the Sun reaches the Earth through the radiation process.

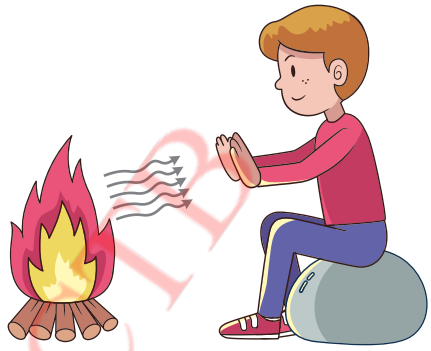

Figure 10.13 Radiation of heat

10.4 THERMAL INSULATION IN BUILDINGS

Material objects such as cork, foam, wool, cotton, timber, ceramic tiles, and some plastic products, etc., are non conductors of heat. These are used for thermal insulation in buildings. Entrance of heat through windows can be reduced using double glazing panes, i.e., two joined glass panes having air in between them. There are special paints whose coating is also helpful in thermal insulation.

10.4.1 The Vacuum Flask

A vacuum flask is a double walled vessel **(Figure 10.13)**. It is designed such that it hardly allows heat to enter into the flask or to come out of it. Therefore, it keeps the temperature of its contents for several hours. As a result, the liquids placed in it remain hot or cold for a longer period.

Figure 10.14 Vacuum flask

KEY POINTS

- The energy that transfers from one object to another because of a temperature difference between them is called heat.
- All matter is composed of tiny particles, i.e., atoms, molecules or ions. The particles are always in a state of constant motion. Due to this motion of material particles, all material objects have an average kinetic energy.
- Solids expands when heated and contracts when cooled. Some solids expand very little so that we may not notice the expansion. However, some solids expand or contract significantly on heating or cooling.
- Hot riveting is a common method for fastening two metal plates firmly.

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- When a liquid is heated, its particles begin to move fast, inter particle distances increase and so the liquid expands. The reverse happens when the liquid is cooled.
- When a gas is heated, its particles move fast and inter particle spaces increase. As a result the gas expands and develops pressure on the walls of the container. The reverse happens when the gas is cooled.
- In conduction, molecules of an object transfer a part of their energy to the neighbouring molecules. This is the mode of transfer of heat in solids.
- In convection, heat is transferred by actual movements of molecules of the liquids or gasses.
- In radiation, heat is emitted by the source in the form of rays. Heat from the sun reaches us by this method.

QUESTIONS

10.1 Encircle the correct option.

1. The degree of hotness or coldness is called:

a. thermal contraction
b. thermal expansion
c. temperature
d. heat

2. The bulb of the thermometer is filled with:

a. oil
b. alcohol
c. water
d. salt

3. Centigrade scale is also called:

a. Fahrenheit scale
b. Kelvin scale
c. Absolute scale
d. Celsius scale

4. The temperature of boiling water in centigrade scale is:

a. 0°C
b. 32°C
c. 37°C
d. 100°C

5. The temperature of melting ice in Fahrenheit scale is

a. 0°F
b. 32°F
c. 100°F
d. 212°F

6. When a 10 cm iron rod is heated to high temperature:

a. its volume decreases.
b. its volume increases.
c. its density remains the same.
d. none of these.

7. The average energy due to movement of molecules in a substance is called:

a. potential energy.
b. electric energy.
c. kinetic energy.
d. chemical energy.

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8. **The energy that transfers from one object to another due to the temperature difference is called:**

a. atomic energy
b. heat energy
c. light energy
d. sound energy

9. **The gaps are left after every few metres in the railway tracks, so that:**

a. they cannot be de-tracked in summer due to expansion.
b. they cannot be de-tracked in winter due to expansion.
c. they cannot be de-tracked in summer due to contraction.
d. they cannot be de-tracked at night due to contraction.

10. **The rise of liquid in the thermometer is due to:**

a. evaporation
b. contraction
c. expansion
d. sublimation

11. **The contraction of the objects on cooling is due to:**

a. reduction in size of the particles.
b. increase in size of the particles.
c. increase in inter particle distances.
d. decrease in inter particle distances.

12. **An empty steel container is sealed and heated, which of the following properties of the gas is likely to increase?**

a. mass
b. pressure
c. volume
d. density

10.2 Give short answers.

1. Define heat.
2. Name three modes of heat transfer.
3. Which two temperatures are the base of Celsius and Fahrenheit temperature scales?
4. Give five examples of good conductors of heat.
5. Give five examples of bad conductors of heat.

10.3 Constructed Response Questions

1. How are expansion and contraction useful in thermometers?
2. Explain why hot air balloons rise up.
3. What does amongst the solid, liquid or gas expand fast and why?
4. Expansion and contraction can be helpful in many areas of life. Explain.
5. What do you mean by kinetic energy of particles?
6. Substances do not expand or contract at the same rate. Why?
7. Describe the uses of expansion and contraction of liquids.

10.4 Project

Teacher Guide

Facilitate students investigate the peculiar behaviour of water during contraction and expansion.

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11 Technology in Everyday Life

Students' Learning Outcomes

After studying this chapter, students will be able to:

- Design a model to demonstrate drip and sprinkler irrigation system for conservation of water.
- Use different techniques of preserving foods like orange juice, apple jam and pickles.
- Make a simple Stethoscope.
- Make a sanitizer using suitable substances

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VOCABULARY

Drip Irrigation
Application of water only to the root zone of the plants

Sprinkler Irrigation
Application of water on the surface of crop and soil

Sanitizer
A liquid mixture used to kill germs

Stethoscope
A medical device used for listening heart beat and counting pulse rate of human body

We have learnt about

- Growing seasonal plants and vegetables
- Preparation of milk products

In this chapter we will learn about:

- Drip and sprinkler irrigation system
- Techniques of preserving foods
- Making a simple stethoscope
- Making a sanitizer

11.1 DRIP AND SPRINKLER IRRIGATION

Drip Irrigation

Drip irrigation is a type of irrigation system by which wastage of water and nutrients is controlled by allowing water to drip slowly to the roots of plants. This system distributes water through a network of pipes, valves, tubing, etc.

Sprinkle Irrigation

Sprinkle irrigation involves use of pipes to distribute water with the help of spray heads which moisten the whole soil surface.

Activity 11.1 Making a simple drip irrigation system

Material required

Plastic bottles, drip pipes each fitted with needle and valve/stopper, glue gun, thread, small sized screw driver potted plants, etc.

Procedure

1. Take clean plastic bottles, cut there bottom ends and make holes in their lids using hot screw driver.
2. Hang the bottles above the potted plants with some supports with the help of the thread.
3. Attach the needle ends of the drip pipes with the stems of the potted plants in such a way that the needles can drip water to the roots of the plants.
4. Insert the other ends of the drip pipes in the bottles through holes in their lids.
5. Put some glue with the help of glue gun to fix the hole and pipe.
6. Fill the bottles with water through their cut ends.
7. Water will start dripping and easily be able to reach plant roots.
8. We can stop dripping of water with the help of stoppers or valves fitted in the drip pipes.

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Activity 11.2 Sprinkler irrigation system

Material required

Plastic bottle, plastic pipe, tub or plastic water tank, glue gun, iron nail, etc.

Procedure

1. Take a plastic water tank, make a hole in it slightly above its bottom and place it at certain height.
2. Fix one end of the plastic pipe in the hole made in water tank.
3. Put some glue with the help of glue gun to fix the pipe in the hole in water tank.
4. Fix the other end of the pipe over the mouth of a plastic bottle and apply the glue with the help of glue gun.
5. Make small holes in the bottom of the plastic bottle with the help hot iron nail.
6. Hang the plastic bottle over the plants.
7. Fill the water tank with water containing dissolved chemical fertilizers.
8. The water with dissolved salts (fertilizers) will flow through the pipe and begin to sprinkle over the plants through the holes in plastic bottle as shown in Figure.

11.2 TECHNIQUES OF PRESERVING FOODS

The techniques used for food preservation involve preventing growth of microorganisms in the food. It is done by drying/dehydrating and adding some preservatives in the food.

Activity 11.3 Making and preserving pickles

Material required

Unripened mangoes, pickle jar, salt, vinegar (preservative), mustard seeds etc.

Procedure

1. Take some unripened mangoes, cut them into pieces and make them dry by keeping in the sun.
2. Put the dried pieces of mangoes in salt water and keep it overnight.
3. Take the dried pieces of mangoes in jar and add vinegar solution (preservative) in to it.
4. Air tight the jar with lid.
5. After 15 days, we will observe pickles in the jar.

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Activity 11.4 How to prepare onion pickle?

Material required

2 cinnamon sticks, 6 whole cloves , pinch crushed red pepper flakes, 1 cup (240 mL) of vinegar, ½ cup (120 mL) freshly-squeezed lime juice, ½ cup (100 g) of sugar, 1 tablespoon of common salt

Procedure

1. Add sliced onions to a bowl. Pour enough boiling water to cover them. After one minute, drain water and transfer onion to a glass jar with a lid.
2. Heat cinnamon, cloves and the red pepper flakes in a small saucepan over medium flame for 3 to 5 minutes until fragrant.
3. Add vinegar, lime juice, sugar and salt.
4. Heat and cook until sugar and salt are dissolved.
5. Taste for sweetness, then add more sugar if needed.
6. Pour brine over onions.

Activity 11.5 How to prepare lemon pickle?

Material required

Lemons (cut into circular slices = ½ kg), sugar (1½ cup), acetic acid (1 cup)

Procedure

1. Boil the lemon slices separately in their own juice to make them soft.
2. Add sugar and acetic acid to the cooked mixture.
3. Leave outside for about 15 days.
4. Keep it in refrigerator.

Activity 11.6 Making and preserving Jam

Material required

Sliced apple (2 bowl), sugar (1/3 cup), cinnamon (1 small stick), orange zest (1 table spoon), lemon juice (preservative)

Procedure

1. Take a jar, wash it with water and place it for drying.
2. Mix the sliced apple, sugar, cinnamon stick, orange zest and lemon juice..

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3. Cook the mixture at medium heat, stir it from time to time until the mixture comes to simmer
4. Reduce the heat to medium-low and allow the mixture to continue to slightly simmer for 20 t
5

Activity 11.7 Making and preserving orange juice

Material required

Y shaped tube, fine plastic tube, cotton, balloon, scissors, etc.

Procedure

1. Rinse the orange underwater.
2. Peel the oranges and slice them into four parts.
3. Add some honey or sugar and a few ice cubes.
4. Place the sliced oranges into the grinder.
5. Grind the slices until they become juicy.
6. Sieve the juice over a mesh strainer.
7. Put the juice in glass container and seal them tightly.

11.3 SIMPLE STETHOSCOPE

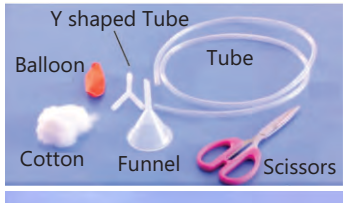
Activity 11.8 Making and preserving apple orange juice

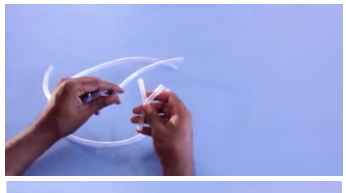
Material required

Y-shaped tube, fine hallow plastic tube, cotton, balloon, scissors, etc.

Procedure

1. Take two pieces of fine hallow plastic tubes.
2. Fix one end of each hallow tube over each of the upper limbs of Y-shaped tube.
3. Fix the cotton swabs on the free ends of the two fine hallow tubes fitted with the limbs of Y-shaped tube.
4. Take another slightly long piece of fine hallow tube and fix its one end over the third limb of Y-shaped tube.
5. Fix the free end of the long hallow tube over the stamp of the funnel.





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6. Cut the balloon from its neck and wrap the lower part of the balloon over the funnel.
7. A simple and home made stethoscope is ready for use.

11.4 HAND SANITIZER

Activity 11.9 Preparation of sanitizer

Materials

Isopropyl alcohol, glycerin, distilled water, plastic or glass container

Procedure

1. Take four cups of isopropyl alcohol and one-fourth cup of house hold hydrogen per oxide, one teaspoon full of glycerin and one cup of distilled water.
2. Mix all the ingredients in a container.
3. Hand sanitizer is ready for use.

Activity 11.10 Home made sanitizer

Materials

Alcohol, aloe vera gel, essential oil such as tea tree oil or lavender oil or lemon juice.

Procedure

1. Mix alcohol and aloe vera in the ratio of 2:1.
2. Add few drops of essential oil or lemon juice as required.
3. A home made sanitizer is ready for use.

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KEY POINTS

- Technology is the application of scientific knowledge in daily life.
- Irrigation can be done by two methods.
- Drip irrigation is watering to the roots of plants under the soil surface.
- Sprinkler irrigation is spraying water on the soil surface bearing plants.
- Preservatives are used to preserve foods.
- Brine water is a mixture of salt and water.
- Stethoscope is used to check heart beat and blood pressure.
- Sanitizers are used to kill germs.
- Hand sanitizer is an antiseptic used to clean hands without using water.
- It is a medicine used to stop the growth of germs.

QUESTIONS

11.1 Encircle the correct option.

1. Conservation of water means

(a) a using water (b) save water

(c) avoiding water (d) wasting water

2. While preparing pickles, which is not used as preservating agent:

(a) honey (b) salt

(c) vinegar (d) pepper

3. Which is not used in making mango pickle?

(a) mango slices (b) honey

(c) table salt (d) turmeric powder

4. Which is not used in the preparation of lemon prickle?

(a) lemon (b) sugar

(c) acetic acid (d) tea leaves

5. Which is not used in the preparation of orange juice?

(a) garlic (b) orange

(c) sugar (d) water

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11.2 Write short answers.

1. What type of irrigation is more beneficial either drip or sprinkler?
2. List the ingredients required for preparation of mango pickle.
3. What are the ingredients required for preparation of onion pickle.
4. Name the ingredients required for preparation of lemon pickle.
5. State the ingredients required for preparation of orange juice.

11.3 Answer the following questions.

1. What does irrigation mean? Explain drip and sprinkler irrigation.
2. Describe preparation of mango prickle?
3. Write the preparation of onion prickle?
4. Describe the preparation of lemon prickle?
5. State the preparation of orange juice.

11.4 Constructed Response Questions

1. Why should farmers implement rain water harvesting.
2. Which is the best technology to preserve meat, milk and fish products.
3. How can technology enhance students learning.
4. What keeps our food fresh for long time.

11.5 Investigate

1. Find out how the technology helped during the pandemic COVID-19.
2. Take a thermometer, check and note the temperature of your classmate.

11.6 Project

Prepare pickle by using mustered oil at home.

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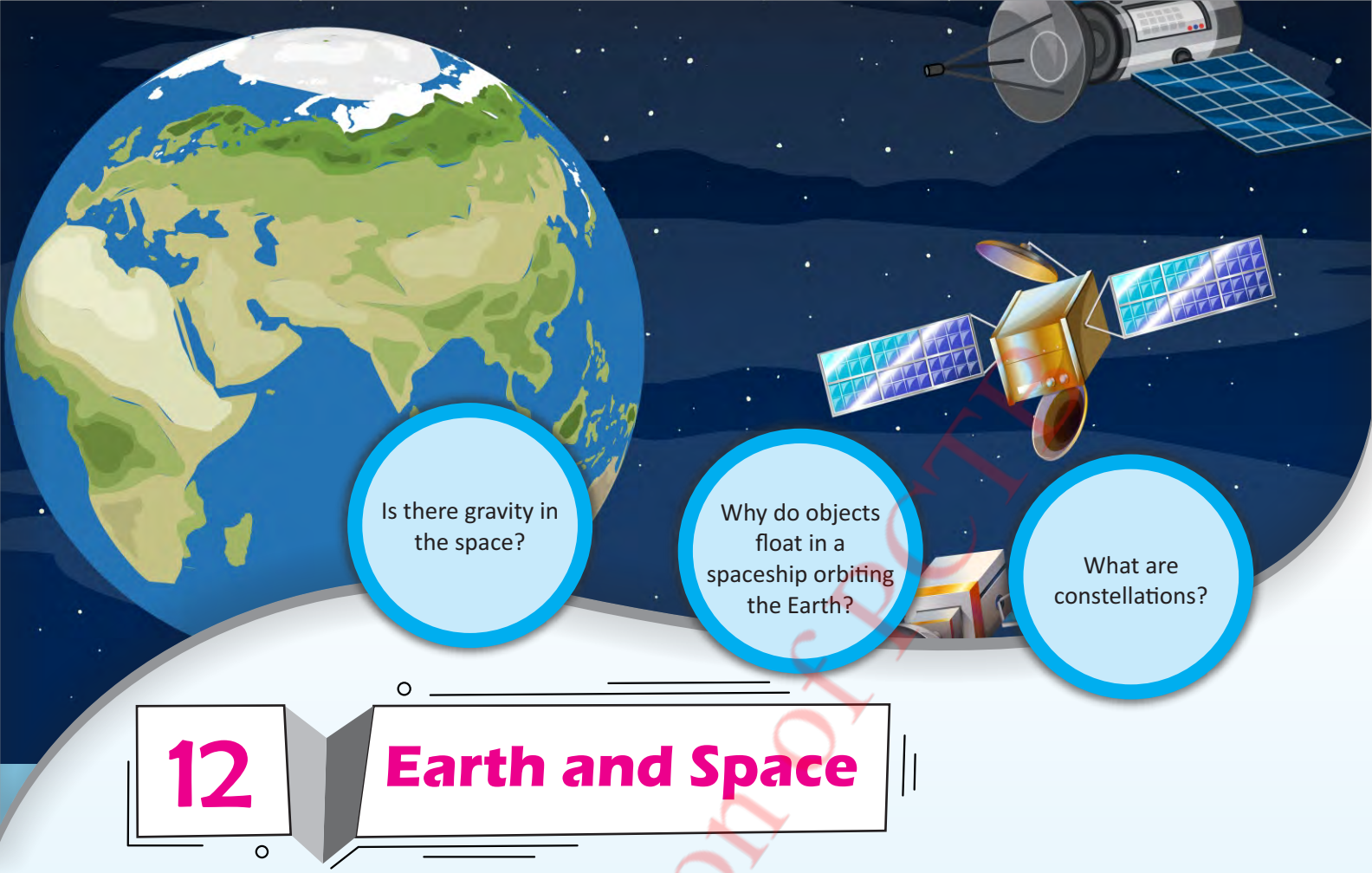

12 Earth and Space

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Students' Learning Outcomes

After studying this chapter, students will be able to:

- Recognize that the force of gravity keeps planets and moons in their orbits.
- Differentiate between mass and weight, using examples of weightlessness experienced by astronauts on the surface of the Moon.
- Recognize that tides are caused by the gravitational pull of the Moon
- Describe the effects of the Earth's annual revolution around the Sun, given the tilt of its axis (e.g., different seasons, different constellations visible at different times of the year).
- Describe how seasons in Earth's Northern and Southern Hemispheres are related to Earth's annual movement around the Sun.

VOCABULARY

Mass
The amount of matter in an object

Weight
Gravitational force acting on an object

Weightlessness
A situation where a mass has zero weight

Tides
The waves that move through an ocean in response to the forces exerted by the Moon or the Sun

Recall what you have learnt

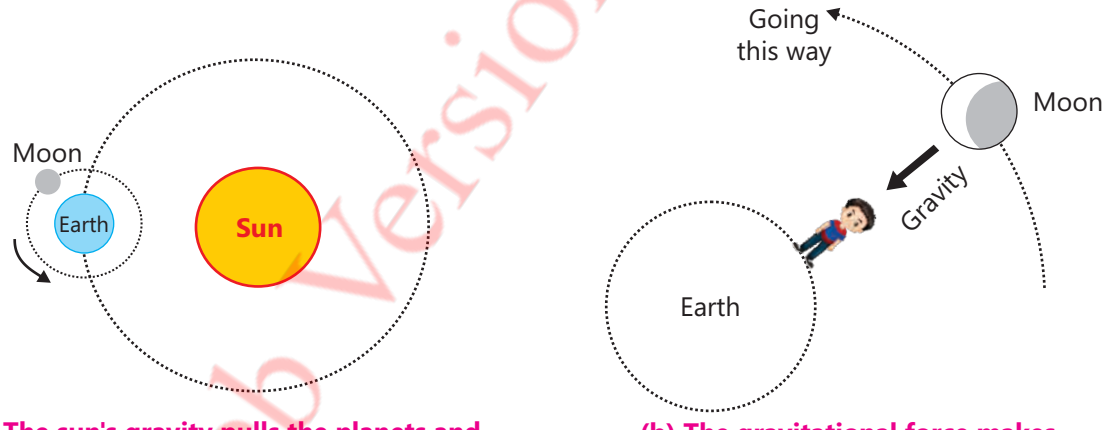
We have learnt about solar system (The Sun and Planets) and that the Earth being part of the solar system is the third planet from the Sun. The surface of the Earth is made of water, air and solid ground. Its atmosphere consists of nitrogen, oxygen, carbon dioxide and other gases. Mass of the Earth is about 6×10^{24}kg. The Earth is the only planet where life exists.

In this chapter we will learn:

- Gravitational force
- Mass and weight
- Weightlessness
- Tides
- Annual rotation of the Earth around the Sun

12.1 GRAVITATIONAL FORCE

Every object in this universe attracts every other object towards its centre. The force of attraction between objects (masses) is called **gravitational force**. The effect of the gravitational force between two small masses is too little to be felt. However, the effects of gravitational forces exerted by massive objects such as the Sun and the Earth are easily observable. Planets are revolving around the Sun and moon revolves around the Earth due to gravitational force **(Figure 12.1)**. If there is no gravitational force of the Sun, the planets will not continue to revolve around it.



(a) The sun's gravity pulls the planets and their moons to orbit around it.

(b) The gravitational force makes the moon to move round the Earth

Figure 12.1 Skin cells in skin tissue (epithelial tissue)

The space around an object where gravitational force acts is called its **gravitational field**.

12.1.1 The Earth's Gravity

The gravitational force or gravity of our Earth pulls the objects, which are within its gravitational field towards its centre. Thus due to the Earth's gravity, the things dropped from some height, fall to the ground.

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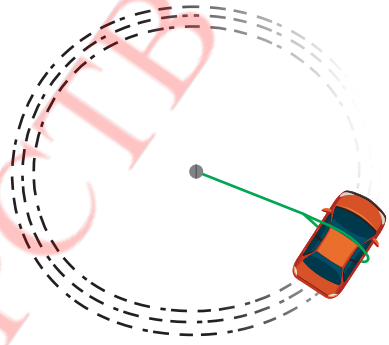
Informative

The Earth takes one year to move once around the Sun and Moon takes 29 days to move once around the Earth.

Activity 12.1

1. Take a battery operated toy car.
2. Tie a string around it.
3. Tie the other end of the string to a nail fixed on the floor.
4. Switch on the car and observe its motion.
5. What will happen to the toy car when the fixed end of the string is made free.
6. Observe its motion by making it free.
7. Relate your observation with the orbital motion of the moon around the Earth.



12.2 MASS AND WEIGHT

Anything that has mass and occupies space is called **matter**. **Mass** is a measure of the amount of matter in an object. Its value does not depend on its location. The gravitational force acting on an object is called its **weight**. The value of weight can be changed with location of the object on the Earth's surface, on the Moon, or on other planet and in the space. Mass and weight are measured in different units. The unit for mass is kilogram (kg). As weight is a force, its unit is newton (N).

The weight of an object in the Earth's gravitational field depends on two factors:

- Mass of the object
- Acceleration due to gravity

The stronger the gravity, the greater the acceleration due to gravity (g). If acceleration due to gravity (g) is constant, then weight (w) increases with the increase in mass (m). If mass (m) is constant then weight increases with the increase in gravity (g).

Mathematically we can write:

$$W = mg$$

Where, W = weight of the object

m = mass of the object

g = acceleration due to gravity

Thus at the position where the same force of gravity acts on two objects of different masses, the object with bigger mass has the greater weight.

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Difference between mass and weight.

Mass	Weight
(i) The quantity of matter in an object is called its mass.	(i) The gravitational force acting on an object is called its weight.
(ii) The mass of an object remains constant everywhere, whether it is measured at a point far away from the centre of the Earth or very close to its centre.	(ii) Weight of an object is not a constant quantity as its value is different at different distances from the centre of the Earth.
(iii) Mass of an object cannot be zero.	(iii) Weight of an object may be zero.

Informative

The weight of an object of mass 1 kg on Earth surface is about 10 N.

12.3 WEIGHTLESSNESS

The weight of an object is due to the gravitational force acting on it which may vary from place to place. An astronaut when leaves the Earth for traveling in space, gets changes in his weight. As he goes far from the Earth, its weight decreases. If he lands on the Moon's surface, his weight will be less due to smaller gravity of the Moon as compared to that of the Earth. Gravity of the Moon is six times less than that of the Earth.

Weightlessness is a situation where a mass has zero weight. Things float around in a satellite and spaceships orbit the Earth as they have no weight **(Figure 12.2)**. In fact, gravity of the Earth causes the satellite or the spaceship to circle the Earth. Hence, all objects inside a satellite become weightless. Therefore, all objects are to be fixed inside the satellite, otherwise they will float away. Astronauts have foothold to keep them still while they are working. They sleep in sleeping bags strapped to the walls of the cabin so that they do not bump into other objects when they are asleep. Sometimes, it looks as if they are standing along the wall of the cabin.

Figure 12.2 **Astronaut in space**

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Activity 12.2

Take a plastic bottle filled with water. Hold it upside down at certain height. Remove its lid and drop it. Observe what happens. Why does it happens so?

Activity 12.3

Teacher Guide

Facilitate students to conduct the activity as under:

- Arrange a visit to a high rise building in a town having an elevator.
- Carry along a scale for weighing.
- A group of 3 or 4 students should enter the elevator.
- One student should stand on the scale. Note the weight of student on the scale as the elevator just starts moving. Also note the weight while coming back just before stopping.
- Conduct an interactive discussion on weight:
  1. While just moving upwards.
  2. While just before stopping.

Informative

What will be the weight of the objects falling freely from certain height?

12.4 TIDES

Tides are the waves that move through oceans in response to gravitational force exerted by the Moon or the Sun. The winds push the surface water in the oceans into ripples called **waves.** These waves move towards the sea shore. When they go back after striking the seashore, it is noticed as the sea shrinks away at the shore and then gradually regains its water level. Such daily changes in the level of ocean water are known as tides. These are caused by the gravitational force of the Moon and the Sun as well as the rotation of the Earth on its axis.

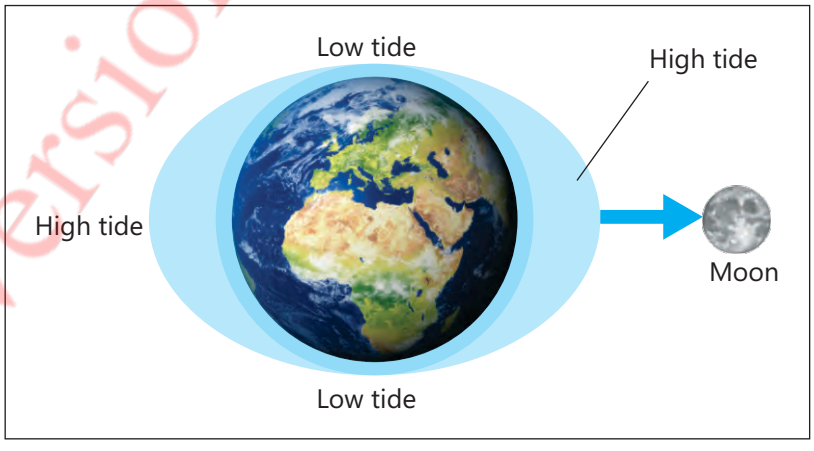

Figure 12.3 Tides due to gravitational pull of the moon

The Moon is closer to the Earth than the Sun. It pulls the ocean water more strongly. At high tide, the water level rises up the shore. At low tide, it recedes back at regular intervals. As the Earth spins, each place has a high tide twice a day. The water bulges out on both sides of the Earth as shown in **Figure 12.3**.

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Informative

When the Sun and Moon lined up with the Earth, their combined gravitational pull creates higher tides called spring tide. It happens when the Moon is in its new phase or full phase.

Informative

- The Moon's pull is strongest on the part of the Earth directly facing the Moon.
- Low tides help the fishermen move forwards in the sea and high tides help them come back more easily.

Do you know?

- The use of tides as a renewable energy source to generate electricity is called tidal energy
- The Moon creates tides also in our atmosphere. They are called lunar winds. Lunar winds move eastwards in the morning and westwards in the evening.

12.5 ANNUAL REVOLUTION OF THE EARTH AROUND THE SUN

We have different seasons in different parts of the world in a year. The seasons on the Earth are due to its revolution around the Sun and that it tilts on one side. The Earth moves around the Sun. Such movement of the Earth is called its **revolution** around the Sun **(Figure 12.4)**. The path the Earth takes to revolve around the Sun is called its **orbit**. The Earth completes one revolution around the Sun in 365 days. We call it one year.

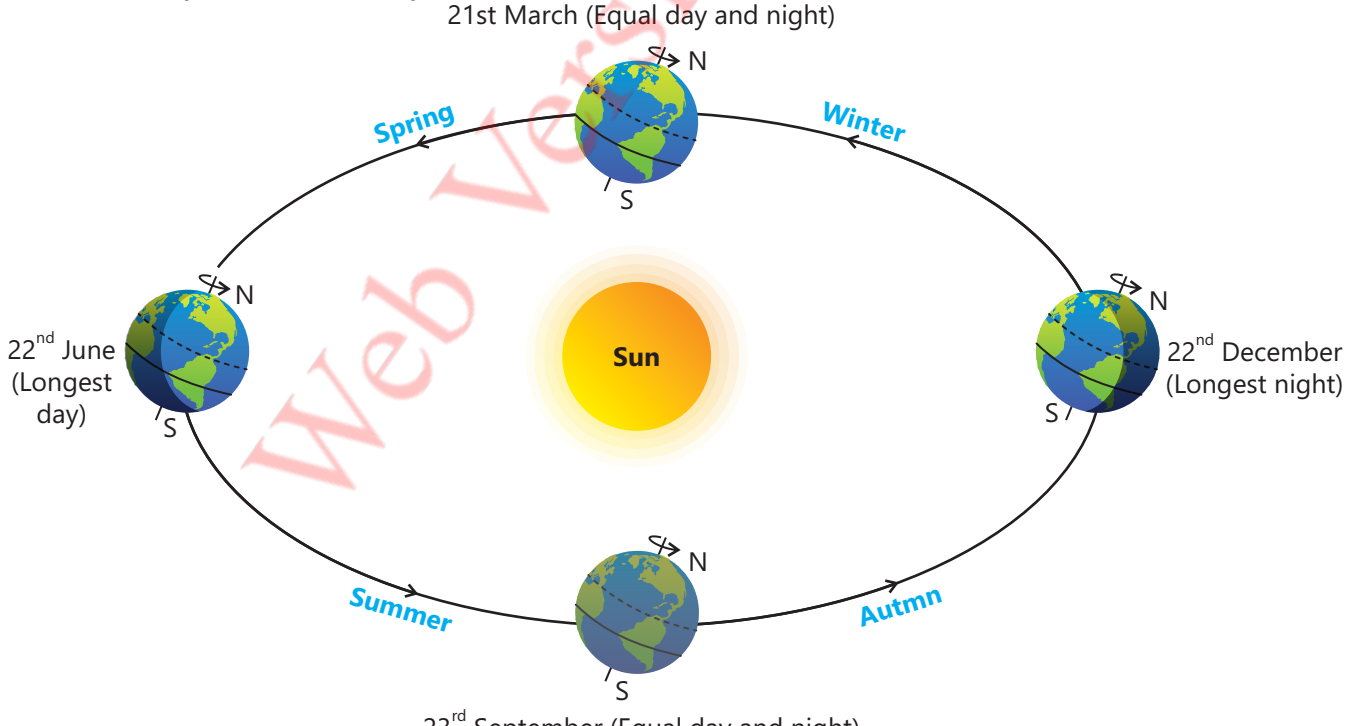

Figure 12.4 Earth's revolution around the Sun

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How do Seasons Change?

The Earth's axis of rotation is tilted at certain angles with respect to its plane of rotation around the Sun. Due to this axial tilt, different regions of the Earth change their distance from the Sun during revolution around the Sun. This causes the change in seasons on the Earth. Pakistan lies in the northern hemisphere of the Earth. Let us see how seasons change in the northern hemisphere of the Earth.

As shown in **Figure 12.4**, on 22nd June, the Earth's northern hemisphere is close to the Sun and is hot as compared to the southern hemisphere which is away from the Sun and is cold. Thus, there is summer season in northern hemisphere of the Earth and winter season in its southern hemisphere in the months of June and July.

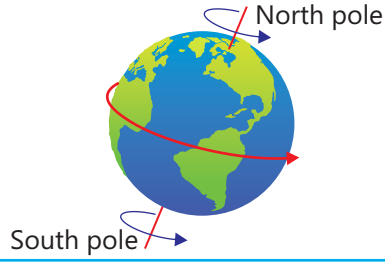
On 22nd December, the Earth's northern hemisphere is away from the Sun and is cold as compared to the southern hemisphere which is close to the Sun and is hot.

Thus, there is winter season in northern hemisphere of the Earth and summer season in its southern hemisphere in the months of December and January.

On 21st March and 23rd September, no hemisphere of the Earth is tilted towards the Sun, hence, there are moderate seasons in northern and southern hemispheres, i.e., spring in northern hemisphere and autumn in southern hemisphere.

Do you know?

- In polar region of the Earth, the Sun never sets in midsummer. It is known as midnight Sun. While in midwinter, the Sun never rises for many days.
- There is summer on the hemisphere leaning towards the Sun while there is winter on the other hemisphere.



Activity 12.4

Arrange a globe in front of a shining lamp. Name the countries where:

1. There is summer season._____
2. There is winter season._____
3. You can see the midnight Sun._____
4. You cannot see the Sun rise for many days._____

Occurence of Day and Night

The half of the Earth's surface faces solar radiations and looks bright on this side of the Earth, there is day. The other half of the Earth's surface remains dark and there is night **(Figure 12.5)**.

During spin, as the dark region of the Earth moves into Sun's light, it gets Sunrise. The Sun comes

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into view and there occurs day. On the other side, as the bright region of the Earth moves out of the Sun's light, it gets sunset. The Sun disappears and there occurs night. In this way day and night occur on the Earth. Since the Earth completes its one rotation about its axis in 24 hours, the total duration of one day and one night is 24 hours.

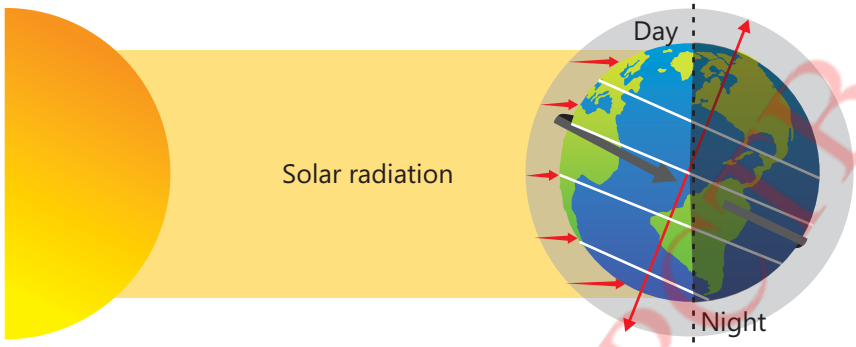


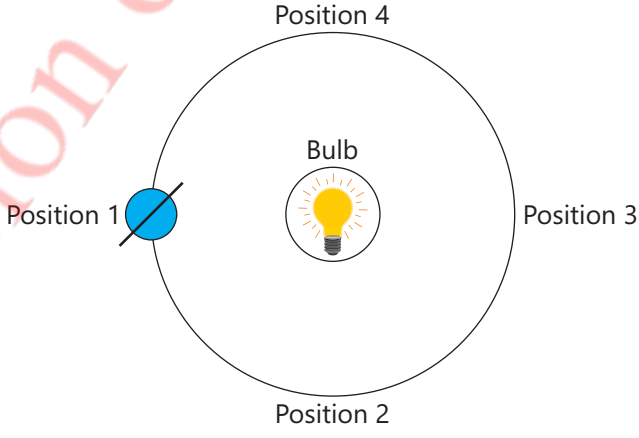
Figure 12.5 Spin of the Earth and occurrence of day and night

Activity 12.5

Teacher Guide

Facilitate students conduct an interactive discussion on:

- Occurence of day and night.
- Observe which part the ball is lighted strongly and will be hot.
- Also observe which part of the ball is away from the bulb and will be cold.
- Make the observations (as above) by placing the ball at position 2, 3 and 4.
- Consider the ball as the Earth, the bulb as the Sun and predict seasons on different parts the Earth at position 1, 2, 3 and 4 during its revolution around the Sun.



12.6 CONSTELLATIONS

At night we see countless number of stars in the sky. Some groups of stars look forming a specific pattern or shape. This specific pattern of stars is known as **constellation**. The constellations are helpful in mapping the sky. Earth's revolution around the Sun causes the constellations appear during certain part of the year. It is easy to recognize a star by constellation. Ursa Major, Great bear, Leo, and Orion are some famous constellations.

Ursa Major or big dipper: Ursa Major or big dipper constellation **(Figure 12.6)** consists of seven stars. Four stars make the bowl and three stars form its handle. A bright star on the end of the bowl points to the **pole star**. It is an area of the sky which can be used for reference purpose for the

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whole sky.

Leo: Leo **(Figure 12.7)** is another famous constellation which is seen on th sky from March to May each year.

Orion: The pattern of star in Orion is shown in the **Figure 12.8**.

Great bear: The pattern of star in Great bear is shown in the **Figure 12.9**.

Figure 12.6 Ursa Major

Figure 12.7 Leo

Figure 12.8 Orion

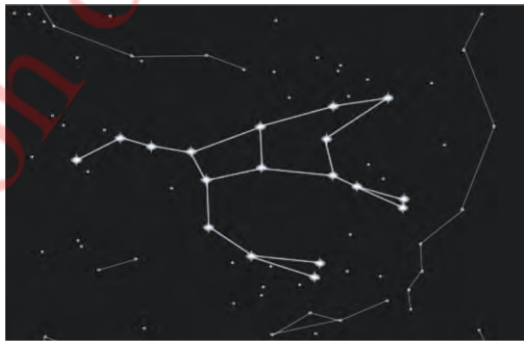

Figure 12.9 Great bear

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Informative

- ***Where stars are born***

There are huge clouds of dust and gas spread out across the universe. These clouds are called nebulae. A nebula may form from the gas and dust produced when a star explodes in a supernova. It may also be developed as gravity pulls together the gas and dust in intergalactic space. In this type of nebula, the forces of gravity between the atoms and molecules of helium and hydrogen gas bring them together into a huge ball. The force of gravity continues to act between the gas particles and squashes them closer and closer together, and the pressure inside the ball increases. Eventually, the pressure pushing on the hydrogen atoms becomes so great that they fuse together to make helium atoms and release energy as heat and light. Gradually, the ball begins to glow and eventually, as the pressure continues to increase and more hydrogen is converted into helium, the ball starts to shine and becomes a star. The star is then said to be "born". As this " birthing" process takes place inside nebulae, They are called stellar nurseries and many stars can be forming inside them at the same time.

- **Astronomy across the world**

  Even the earliest humans would have looked up at the night sky and wondered at it. As time went on, human civilisations began to explain the night sky in a variety of ways and related it to events taking place on the Earth. Today we are still fascinated by the night sky, and scientists study it to find out more about it and our place in the universe. This in turn helps us try to understand to existence, and for many, this means trying to conserve the conditions on Earth which sustain life by maintaining ecosystems and trying to control climate change.

  Astronomy is the study of objects found in space, such as stars, planets, moons and asteroids. It is also the study of phenomena that occur in space, like the formation of stars, the movement of galaxies and the formation of planets. Scientists who study astronomy are called astronomers and many of them work in observatories around the world, collecting data from huge telescopes which use light or radio waves to look into space. There are major observatories all around the world - some of the biggest can be found in the USA, the Canary Islands and Chile. Most observatories are built away from cities, where the sky is not as polluted, so a clearer view of space can be seen.

Do you know?

There are 88 constellations covering the whole sky. In old days they were used to set direction for navigation in the sea.

Activity 12.6

Learn about the constellations using your library and internet resources.

KEY POINTS

- Gravitational force of the Earth pulls all objects towards its surface.
- The Earth moves around the Sun due to the gravitational force.
- The Moon revolves around the Earth due to the Earth's gravity. The gravity of Earth keeps the artificial satellites move around it.
- Weight is the gravitational force of the Earth acting on an object.
- The tilt and orbital motion of the Earth around the Sun cause different seasons.
- The gravitational forces of Moon and the Sun cause the tides in the oceans.
- Tides are also a source of energy called tidal energy.
- The seasons in the northern part of the world are different from southern part of the world.
- When there is summer season in the northern hemisphere, there is winter in the southern hemisphere.
- Specific patterns of stars on the sky are known as constellations.

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QUESTIONS

12.1 Encircle the correct option.

1. An object is attracted towards the Earth due to:

a. pull
b. push
c. gravity
d. friction

2. Which of the following is the major cause of tides?

a. heating oceans by the Sun
b. gravitational pull of the Moon
c. earthquakes on the surface of the ocean floor
d. change in the wind direction.

3. Seasons on the Earth's surface are caused by:

a. spin motion of the Earth about its own axis
b. orbital motion of the Earth around the Sun
c. tilt of Earth on its axis
d. the tilt of Earth and orbital motion of the Earth around the Sun.

4. What is the season on 22nd June in the southern hemisphere?

a. spring
b. autumn
c. summer
d. winter

5. The weight of an object on Earth's surface is 600 N. What will be its weight on the Moon's surface?

a. 600 N
b. 300 N
c. 200 N
d. 100 N

6. The tides are highest during:

a. day
b. night
c. half Moon
d. full Moon

12.2 Answer the following questions briefly.

1. An athlete can jump 5 metre up on the Earth, how high he can jump on the Moon?
2. A person can throw a shot put 2 metres away. How long will be his throw on the Moon's surface?
3. Which of the Sun or Moon has a greater pull on the ocean's water? Give reason of your answer.

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4. Differentiate force exerted by the Moon on the waters at the near surface and that exerted on the water of far surface.
5. What will be the season in Australia when there is summer in Pakistan?

12.3 Constructed response questions.

1. What happens to mass and weight of an astronaut when he leaves the Earth and travels to the Moon?
2. Comment on the statement: The tides wash in and out of beaches, shores and harbours twice a day.
3. If tides are caused by the gravity of the Moon, why other objects on the Earth are not affected by it?
4. What kind of seasons will be on our Earth, if it was not tilted about its axis?

12.4 Investigation:

Select some constellation patterns from internet or library. Paste their images in your notebook. Try to explore those constellations on a clear night sky and share your findings with class.

12.5 Project

- Make your own weighing machine using a spring. You need a spring, a stand, an object of known weight, an object of unknown weight. Using the principle that extension in the spring is proportional to the weight, design your spring balance. Using mathematics, find the unknown weight.
- Make the following studies using library and internet resources.
    1. Why the life of blue stars is less than yellow or red stars?
    2. How does a constellation differ from a galaxy?
    3. Does life exist on other stars?
    4. Do other star have planets revolving around them?

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DENGUE FEVER

INTRODUCTION

The mosquito is considered as an important vector for human diseases. The *Anopheles* mosquito is responsible for the spread of malaria while *Aedes* mosquito is responsible for spreading dengue.

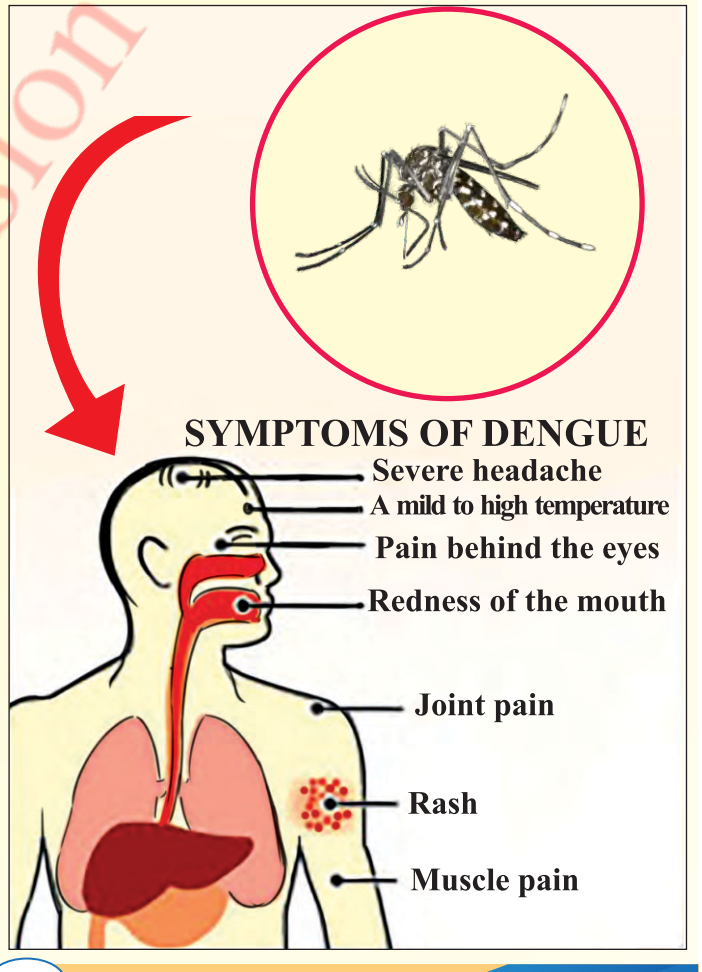
The mosquito hides itself in a variety of places e.g. in the dark corners, behind the picture frames, curtains and under the furniture. It bites human beings almost all the time, but different mosquito species have different feeding times (some feed at night and some feed during the day time, etc) .When an infected female *Aedes* mosquito bites the human being, it transfers the virus into his body which causes Dengue fever. It is an infectious disease of warm and humid parts of the earth.

DENGUE MOSQUITO

The dengue virus multiplies in the body of the female *Aedes* mosquito. The *Aedes* mosquito is of dark brown in colour with white spots and stripes on its body. The mosquito is responsible for the transmission of the diseases like malaria and yellow fever. In order to save oneself from these diseases, it is very important that various preventive measures, including destruction of the breeding sites should be adopted.

DENGUE VIRUS

Four different types of dengue viruses are responsible for Dengue Fever. One or more than one type of virus can enter into female *Aedes* mosquito while biting an infected person and when this mosquito bites other human being, injects virus along with saliva. Recovery after infection with one type of virus can produce lifelong immunity to that type but severe complications can occur on secondary infection by other serotype of virus, serious disease can occur.



SYMPTOMS OF DENGUE FEVER

The salient features of this disease are

- High fever usually above 102°F.
- Severe headache and pain behind the eyes.
- Weakness and fatigue.
- Pain in the muscles and joints because of which it is also called "Break Bone Fever".
- Chill, nausea or rash on the skin may also occur.
- Gradually the white blood cells (WBC) and

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the platelets count decrease.

- Majority of the patients recover after 5-7 days.

COMPLICATION OF DENGUE FEVER

Dengue fever, in severe cases, can develop into Dengue Haemorrhagic Fever (DHF).Patients can present with bleeding. In such cases the patient should be immediately admitted to the hospital. In case of severe disease, it can develop into a more severe form known as Dengue Shock Syndrome (DSS). The initial symptoms of Dengue fever, Dengue Haemorrhagic fever and Dengue Shock Syndrome (DSS) may be similar and difficult to differentiate.

Diagnostic Tests

The diagnosis of this disease is based upon careful observations of the symptoms accompanied with various blood tests.

PREVENTIVE MEASURES AND CONTROL

This disease can be controlled by following the famous saying that "Prevention is better than cure". The best way to avoid this disease is to minimize the chances of contact between the mosquito and the human being. For this purpose people should wear clothes with long sleeves, use mosquito nets and coils, mosquito repellents to keep themselves secure from the mosquito bites.

At household level, every corner of the house should be sprayed with some suitable insect killer and the principles of hygiene should be strictly observed. The water should not be allowed to stand at any place such as flower pots, air cooler, flower vases and the places where animals drink water. Work at community level for spray of insecticides all around your houses, streets etc.

PATIENT MANAGEMENT

The patient is a person who suffers from a disease. A complete understanding of the symptoms of the disease as it progresses through different phases is very important in this regard.

Early Phase

Since this phase is marked by high fever, care should be taken to prevent the rise in temperature. In case of high grade fever sponging with moderately cold water should be done. Paracetamol should be given to the patient on doctor's advice to subside temperature and pain.

Later Phase

The later phase is characterized by the rapid decrease in the fluid level of the patient; therefore the appropriate level of fluid should be maintained in the body of the patient by giving fresh juices or ORS (Oral Rehydration Salt).

In severe cases the patient enters into a condition of unconsciousness or shock. He should be immediately admitted to a hospital and instructions of the doctor should be strictly followed.

EXERCISE

Q.1: What are the symptoms of dengue fever ?

Q.2: Which preventive Measures should be taken against dengue ?

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CORONA VIRUS

Use of mask protect the normal person from corona patient. You should use mask when you are out side the house in market, banks, or any public place. Proper use, and cleaning of masks also affects how well they protect you. Follow these steps for putting on and taking off your mask:

Wash your hands before touching the mask.

Inspect the mask for tears or holes.

Adjust the mask to your face without leaving gaps on the sides.

Cover your mouth, nose and chin.

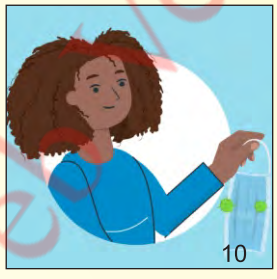
Find the top side where the metal piece or stiff edge is.

Place the metal piece or stiff edge over your nose.

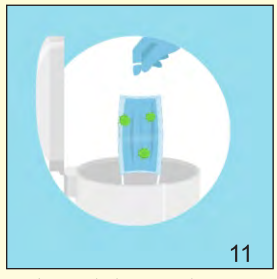
Ensure the colored-side faces outwards.

Avoid touching the mask.

Romove the mask from behind the ears or head.



Keep the mask away from you while removing it.



Discard the mask immediately after use preferably into a closed bin.

Wash your hands after discarding the mask.

Be careful

Don't put masks on anyone who has trouble breathing or is unconscious or otherwise unable to remove the mask without help.

Don't put masks on children under 2 years of age.

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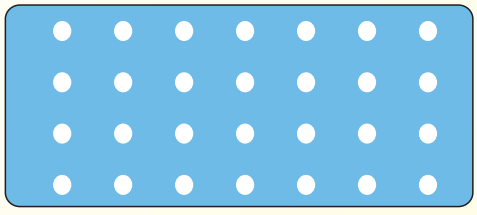
THE METHOD OF MAKING MASK

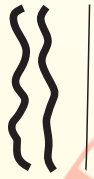
Materials



Cloth

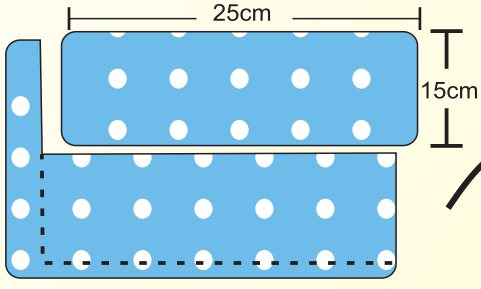
Scissors

Needle and thread

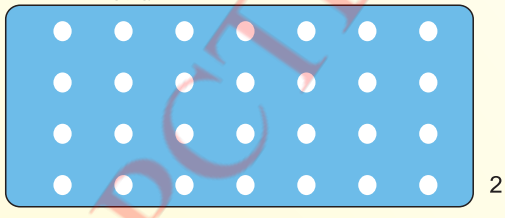


Elastic

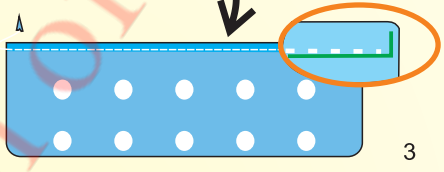
Kitchen paper



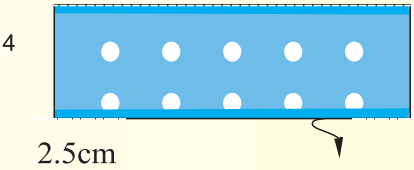
Cut two cloth rectangles 25cmx15cm



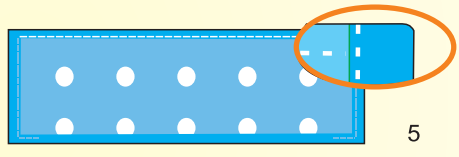
Place on top of each other, lengthways



Fold over the top of the fabric 0.6cm and stitch all the way across

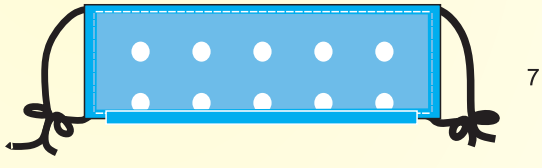


Fold the bottom up and stitch 2.5cm inwards from the edge on either side - this will create a filter pocket



Fold the shorter sides in about 1cm and stitch - leaving a gap to thread elastic

Thread a 15cm piece of elastic through the hem on one side and tie the ends. Repeat on the other side



Put kitchen paper inside pocket as filter

Gather the side of the mask on the elastic and adjust so the mask fits your face. Then, stitch the elastic in place.

Activity : The student should make the mask at home and then bring it to the class to show it to the teacher.

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